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American Fisheries Society.

1890.

TRANSACTIONS

OF THE

AMERICAN

FISHERIES SOCIETY.

NINETEENTH ANNUAL MEETING.

HELD IN THE PARLOR OF THE

BEEBE HOUSE, PUT-IN-BAY,

OHIO,

WEDNESDAY, MAY 14TH, 1890.

J. M. DAVIS, TYPOGRAPHER, 40 FULTON STREET, N. Y.

Officers for 1890-91.

President, EUGENE G. BLACKFORD.....*New York City.*
Vice-Pres't, Dr. JAMES A. HENSHALL......*Cincinnati, O.*
Treasurer, HENRY C. FORD..............*Philadelphia, Pa.*
Recording Sec'y, EDWARD P. DOYLE.....*New York City.*
Cor. Sec'y, Dr. TARLETON H. BEAN.....*Washington, D. C.*

Executive Committee.

W. L. MAY, Chairman - - - - *Fremont, Neb.*
HERSHEL WHITTAKER - - - *Detroit, Mich.*
CALVERT SPENSLEY - - - *Mineral Point, Wis.*
Dr. H. H. CARY - - - - - - *Atlanta, Ga.*
Dr. M. M. HUDSON - - - - - *Hartford, Conn.*
JAMES VERNON LONG - - - *Pittsburg, Pa.*
Dr. R. ORMSBY SWEENY - - - *Duluth, Minn.*

NINETEENTH ANNUAL MEETING

—OF THE—

AMERICAN FISHERIES SOCIETY.

PART FIRST.

MINUTES OF MEETINGS.

THE Nineteenth Annual Meeting of the Society was held on Wednesday, May 14, 1890, at 2 o'clock P.M., in the parlor of the Beebe House, Put-in-Bay, Ohio.

Eugene G. Blackford, the President of the Association, promptly called the meeting to order, and, in the absence of the Recording Secretary, Fred. W. Brown, of Pennsylvania, Edward P. Doyle, of New York, was elected Secretary pro tem.

Before proceeding with the regular business of the Association, the President requested Mr. C. V. Osborne, of Ohio, to explain to the members the programme provided for their entertainment during the meeting.

After Mr. Osborne's explanation, the President, by unanimous consent, appointed C. V. Osborne and Dr. J. A. Henshall, of Ohio, a committee on local entertainment.

Mr. Hasbrouck, of the Castalia Trout Club, extended an

invitation to the Association to visit the ponds of the Club and partake of a trout dinner.

On motion of Dr. H. H. Cary, of Georgia, the thanks of the Society were given the members of the Castalia Trout Club for their kind invitation.

The President read a letter from Mr. Frank Clark, of the United States Fish Commission, regretting his absence from the meeting.

The President then addressed the meeting at length.

PRESIDENT'S ADDRESS.

Gentlemen of the American Fisheries Society :

I congratulate you upon so large an attendance at so remote a place as Put-in-Bay, Ohio. For many of our members to come here involves a journey of some hardship and considerable expense; that we have here to-day gentlemen from Georgia, Pennsylvania, Michigan, Minnesota, and Wisconsin is proof that interest in the Society and its work has by no means lessened.

I hope that when we shall meet at some more central place, although none perhaps can equal this as to beauty of surroundings, a still larger number of our members may be present. All things considered, however, this promises to be one of the most successful of our meetings, and I have no doubt that the object of our Society will be gratifyingly promoted.

It may not be amiss at this point to say something about the original design of this Association, and to give some idea of the work it has accomplished. Eighteen years ago the Society was organized under the name of the American Fish Culturists Association by a few practical fish culturists, who hoped to make it an aid to the financial part of their business, and to secure, if possible, a better and more uniform price for the product of their skill. The aims and

scope of the Society's work were enlarged from year to year, until we now have a Society embracing within its list of members the most distinguished fish culturists of the world.

It has broadened out with its growth in membership until its original object has been forgotten, and the question of how to best advance purely scientific interests of fish culture and fish distribution and fish protection have become of paramount importance.

It is unnecessary for me, perhaps, to remind you of how much we have accomplished in the past, for you have all shared in the labors and are acquainted with the facts. There can be no doubt but that the present United States Fish Commission, with its value and importance and its great success, owes its origin and development, in a great measure, to this Society. Papers read at our several annual meetings have done more than anything else to stimulate the growth of the interests in fish culture and fish protection throughout the United States, and I think we can say, without boasting, that the present advanced condition of this science in this country is due, in a large measure, to the work of the American Fisheries Society.

As illustrative of the practical advance of fish culture and the great results now obtained by it, it may not be out of place for me to give you at this point a brief account of the work of the Commission of which I am the President. This Commission has been remarkably successful, and the past year was one of the best in its history. Its work has been divided into three heads—first, fish propagation; second, fish and game preservation; third, granting franchises for oyster cultivation and protecting natural-growth oyster-beds.

The first and principal work of the Commission is, of course, the artificial propagation of fish. By the terms of the act creating the Commission, they are to examine the streams and lakes of the State, with a view to stocking

them with fish. In this department the Commission is doing a great work. Last year they operated five hatcheries, and the coming year two more will be added. This will give the Commission seven hatcheries, all capable of producing excellent results. These hatcheries are at Caledonia, Cold Spring Harbor, Adirondack, Sacandaga, Fulton Chain, Clayton, and Chautauqua, and their importance is in the order I have given them.

The total output last year of the five then in operation was 31,489,638 fry. Of this number there were 3,099,900 brook trout, 927,500 brown trout, 5,329,000 lake trout, 863,000 California trout, 1,350 quinnat salmon, 78,000 land-locked salmon, 687,188 salmon, 4,600,000 smelts, 30,000 shrimps, 4,100,000 tomcod, 1,900,000 white-fish, 6,053,200 shad, 3,780,000 frost-fish, and 2,625 adult fish of various kinds.

This year's distribution will be much larger than ever before, and an increase of at least 30 or 40 per cent. is looked for.

The entire distribution for the past ten years was, in round numbers, 203,363,600 fry, of which the principal distribution was of lake trout, brook trout, and shad; 39,055,000 of lake trout were distributed, 18,140,000 brook trout, and 81,138,000 of shad.

The correspondence of the Commission from various parts of the State shows conclusively that artificial propagation and stocking have been wonderfully successful. In spite of continuous fishing, consequent to the rapid increase of population, the Adirondack streams, stocked yearly by the Commission, are full of trout, the large lakes in the central part of the State afford excellent lake trout fishing, and shad and salmon are increasing in numbers in the Hudson every year. The Commissioners recently succeeded in obtaining appropriations for the necessary fishways in the last-named river, and as soon as they can be built the work of the Commission in this stream will show

more abundant results. The last Legislature has made an appropriation of $3,500 for a fish-car for fish hatching and fish distribution, and this, it is also believed, will materially aid our work in this department.

The prospects for the future work of the Commission in fish propagation and in stocking streams are excellent, and great results will certainly be obtained.

In the department of fish protection the Commission has been most successful. The Legislature of 1888 provided for the appointment of a corps of fish and game protectors for the State, and created an executive head, to be known as the Chief Game and Fish Protector, all of whom are appointed by and subject to the Fish Commission. This is what the State most needed, and the enforcement of the fish and game laws has been much more thorough and satisfactory.

During the year ending September 30, 1889, 180 suits for penalties were successfully prosecuted, the receipts from fines amounting to $4,104 51.

The work this year has been even more successful, and the results have been most gratifying. At the last session of the Legislature the Commission succeeded in having passed an act for a commission to revise and codify the game-laws of the State. This commission will consist of one member from the Fish Commission, one from the Society for the Preservation of Game, and one Deputy Attorney-General of the State. The work of this Commission will be most important, and the presentation by them to the Legislature and the subsequent adoption of a concise and consistent code of game-laws will do a great deal towards securing the successful and vigorous protection of game and fish.

In the department of oyster culture great progress has been made, although the first surveys are not yet finished; 261 franchises have been issued and $4,520 in fees have been paid into the State Treasury.

A large number of applications for oyster territory are now ready for favorable consideration, and the receipts by the State this year will be correspondingly large.

In addition, the benefit derived by this important industry from this law cannot be overestimated, and is thoroughly appreciated by the oystermen. We think that the Commission, in its various departments, can claim, without boasting, that valuable results have been obtained for the State, and that no investment made by it shows more gratifying returns.

You will pardon me for the time I have taken in speaking of my own State, but the work done by the Commission there is simply indicative of the progress of fish culture, and shows the great value of the work this Society may do and has done in stimulating the interests of the country in the artificial propagation of fish.

Many other States have vigorous and successful commissions, perhaps, of greater efficiency than that in which I am possibly more particularly interested, and that all the State Commissions have been helped by our Society is beyond question. These meetings cannot fail to produce excellent results. Aside from the pleasures of social reunion and intercourse, the mutual expression of practical experiences in fish work is of great value to all of us.

I thank you for the attention you have given me, and congratulate you upon the present standing and membership of the Society, and await your further pleasure.

The Treasurer, Henry C. Ford, presented the financial report of the Society for the year ending May 14, 1890, which report was received, and, on motion, accepted.

TREASURER'S REPORT.

The American Fisheries Society in account with Henry C. Ford, Treasurer.

CR.

May 12, 1890, By cash received from membership dues		$207 00

DR.

May 15, 1889, To cash paid E. G. Blackford, Treasurer, balance due	$5 29	
May 15, 1889, To cash paid A. M. Spangler for printing circulars and postal notices for May, 1889, meeting	4 00	
May 15, 1889, To cash paid for 150 postage stamps	3 00	
May 15, 1889, To cash paid for envelopes	1 00	
June 12, 1889, To cash paid for printing notices of yearly dues	1 00	
June 12, 1889, To cash paid for postage stamps for yearly dues	3 00	
June 12, 1889, To cash paid for stationery and envelopes	1 20	
June 12, 1889, To cash paid for postage stamps for returning receipts, &c	3 00	
May 12, 1890, To cash paid F. W. Brown, wrappers, stamps, envelopes, &c., for sending annual report, &c	7 66	
May 12, 1890, To cash paid Spangler & Davis for printing annual report	101 00	
May 12, 1890, To cash balance on hand	76 85	
	$207 00	$207 00
May 12, 1890, By balance on hand		$76 85

H. C. FORD, Treasurer.

On motion of W. L. May, of Nebraska, the President was authorized to appoint a committee of three to present to the Association nominations for officers for the ensuing year.

The President appointed W. L. May, of Nebraska, J. Vernon Long, of Pennsylvania, and Fred Mather, of New York, as such committee.

Dr. R. O. Sweeny, of Minnesota, moved that the accounts of the Treasurer be audited and allowed.

The motion was unanimously adopted.

Hershel Whittaker, of Michigan, moved that a recess of ten minutes be taken to enable the Committee on Entertainment to prepare a list of papers to be read before the Association.

On re-assembling, Dr. Henshall, from the Committee on Entertainment, reported as follows:

That papers by the gentlemen whose names are given below would be read: Fred Mather, Hoyt Post, Dr. R. O. Sweeny, Hershel Whittaker, Emory D. Potter, Dr. J. A. Henshall, John M. Bissell, John Gay, and William P. Seal.

On motion of Hershel Whittaker, of Michigan, the President was authorized to appoint a committee of three to draft resolutions expressing the sentiments of the Society as to the bill of Senator Paddock relating to the United States Fish Commission now before the Congress of the United States. The President appointed Hershel Whittaker, of Michigan, C. V. Osborne, of Ohio, and W. L. Powell, of Pennsylvania, as such committee.

The following persons were proposed for membership in the Society, and by unanimous consent were duly elected: Charles F. Imbry and George T. Moon, of New York (proposed by E. G. Blackford); Hon. Seymour Brown, of Deerfield, Mich. (proposed by Hershel Whittaker); William P. Seal, Washington, D. C., and A. H. Miller, 1020 Spring Garden Street, Philadelphia (proposed by Henry C. Ford); Hon. J. J. Stranahan, Chagrin Falls,

Ohio (proposed by J. A. Henshall), and Hon. Emory D. Potter, Sandusky, Ohio (proposed by Fred Mather).

On motion of Dr. R. O. Sweeny, Washington, D. C., was chosen as the place for holding the next meeting of the Association.

On motion of Hershel Whittaker, of Michigan, the question as to the time for holding the next meeting was made a special order for the evening session.

On motion of C. V. Osborne, of Ohio, the Secretary was directed to write the members of the Fishing Club at Middle Bass Island to attend the evening session of the Society.

Dr. Sweeny, of Minnesota, moved that Mr. Hasbrouck, of the Castalia Trout Club, be invited to sit with the Society during its sessions.

The motion was unanimously adopted.

The President read letters, regretting their inability to be present at the meeting, from Col. Marshall McDonald, W. T. Dennis, N. D. Tomlin, Charles G. Atkins, and W. P. Seal.

The reading of papers then began and continued for some time. These papers will be found in full in Part Second of the proceedings.

Dr. R. O. Sweeny moved that the question as to the advisability of printing an edition of the reports of the Society from its organization be referred to the Executive Committee.

The motion was unanimously adopted.

Henry C. Ford, President of the Fish Commission of Pennsylvania, addressed the meeting on the work of the Pennsylvania Fish Commission, and gave testimony as to the value of fish-ways. He said that large numbers of shad have been seen ascending the fish-ways at Lackawaxen.

On motion, Dr. R. O. Sweeny was permitted to read two papers by title, which papers the Secretary was directed to print in the annual report.

A number of interesting papers were read, after which, on motion, a recess was taken until 8 P.M.

Minutes of an adjourned meeting of the American Fisheries Society, held Wednesday, May 14, at 8 P.M., in the parlor of the Beebe House, Put-in-Bay, Ohio.

Reading of the minutes of the afternoon session was on motion dispensed with.

Henry C. Ford, of Pennsylvania, proposed for membership C. T. Hasbrouck, of Cleveland, Ohio; Dr. J. A. Henshall, of Ohio, proposed Mr. J. E. Gunkell, of Toledo, Ohio.

By unanimous consent the by-laws were set aside, and the gentlemen elected to membership by acclamation.

Hershel Whittaker, of Michigan, from the committee appointed for the purpose, reported the following preamble and resolution, which, upon motion, were unanimously adopted:

Whereas there is now pending before Congress a proposition to change the organization of the United States Fish Commission, attach it and make its chief and employés of every grade and position subject to the appointment and removal by the Secretary of Agriculture, which legislation we feel to be directly inimical and prejudicial to the progress and proper consummation of the original intent and present practical and efficient work of the Commission;

Resolved, That the American Fisheries Society, which for the past twenty years has been actively interested both in the science and practical development of fish culture, does most earnestly and emphatically protest against such legislation, and therefore would respectfully urge our Senators and Representatives, by every proper means, to oppose and defeat such obnoxious enactment.

On motion, the Secretary was instructed to have these resolutions printed and sent to every Senator and Representative in Congress.

Mr. Mather, from the committee appointed to make nom-

inations for officers for the Society for the ensuing year, presented the following report:

To the American Fisheries Society :

Your Committee on Nominations for officers would respectfully report the following:

President, EUGENE G. BLACKFORD....New York City.
Vice-President, DR. JAMES A. HENSHALL, Cincinnati, O.
Treasurer, HENRY C. FORD...........Philadelphia, Pa.
Recording Secretary, EDWARD P. DOYLE, New York City.
Cor. Sec'y, DR. TARLETON H. BEAN, Washington, D. C.

EXECUTIVE COMMITTEE.

W. L. MAY, Chairman....................Fremont, Neb.
HERSHEL WHITTAKER................Detroit, Mich.
CALVERT SPENSLEY............Mineral Point, Wis.
DR. H. H. CARY...........................Atlanta, Ga.
DR. W. M. HUDSON...................Hartford, Conn.
JAMES VERNON LONG...............Pittsburg, Pa.
DR. R. ORMSBY SWEENY..............Duluth, Minn.

On motion, the report of the committee was received and accepted.

Upon motion, the Secretary was then directed to cast one ballot for the officers recommended by the Committee on Nominations, which was done, and the President declared the officers named duly elected.

The special order for the evening session then came up, and it was moved and seconded that the next annual meeting of the Society be held at Washington, D. C., the second Wednesday in February, 1891.

The motion was put and carried.

At this point Mr. Osborne, from the Committee on Entertainment, explained the character of the excursions to be made on the following day, and gave the necessary information to the members as to the time of leaving.

A paper was then read by Hon. E. D. Potter, of Ohio (see Part Second), on Origin of Artificial Propagation of Fishes in the United States.

On motion of Dr. Cary, thanks of the Society were voted Mr. Potter at the conclusion of his paper.

Mr. Broman, of Put-in-Bay, one of the oldest fishermen of that place, gave the Society some interesting information as to the habits of white-fish.

A paper was read by Dr. J. A. Henshall, as to fish protection. (See Part Second.)

A paper by John A. Bissell, of Michigan, entitled "The Grayling," and one by the same gentleman entitled "Michigan White-fish Hatchery," were ordered printed. (See Part Second.)

Mr. Ford, of Pennsylvania, read a paper prepared by John Gay and William P. Seal, of the U. S. White-fish Commission, entitled "Past and Present Aspect of Fish-culture," with an inquiry of what may be done further to promote and develop the science. (See Part Second.)

Mr. Fred Mather moved to reconsider the vote by which the date of the next annual meeting was fixed.

The motion was carried.

The question then recurred on the original motion.

Mr. Whittaker moved to amend so that the meeting should be held the last Wednesday in May.

The amendment was adopted.

The original motion was then carried.

W. L. May, of Nebraska, offered the following resolution, which, upon motion, was adopted:

Resolved, That this Society urge upon the different State Fish Commissioners the necessity of sending to future annual meetings the Superintendents of their respective

State Hatcheries at the expense of proper funds under their control.

On motion the meeting then adjourned.

EDWARD P. DOYLE,
Recording Secretary.

PART SECOND.

EGGS OF PIKE-PERCH—*S. Vitreum.*

By Fred Mather.

On April 25 of the current year I had some eggs of this fish in hand. They were not in good order on receipt, but there were hopes of some. On looking up the literature of the hatching of pike-perch, but little was to be found beyond statistics, and that little was in the reports of this Society, in an article by Mr. James Nevin. On measuring the eggs, my estimate of the number in a quart greatly exceeds that of Mr. Nevin, who gives it as 100,000.

From my notes, taken at the time of receiving the eggs (in water), I find the following: the eggs measure thirteen to the linear inch, 169 to the square inch, and 2,197 to the cubic inch. As there are 57,775 cubic inches in a quart, there would seem to be 126,931 eggs in it; but the above calculation is made on the supposition that the eggs would be piled up in such a way that their diameters are in line, thereby wasting the greatest space in the interstices. As this is not the ase, I have, after careful counting and estimating, added 350 eggs to each thousand for this filling of chinks, and in this case the addition would be 44,450, making the total number of pike-perch eggs in a quart to be, in round numbers, 171,000, which I believe to be nearly

correct if the eggs measure thirteen to the linear inch, as mine did.

In the last report of the New York Fishery Commission I gave an estimate of the number of eggs in a common sun-fish, but did not add for the filling of interstices. Afterwards I gave the facts to a newspaper man at more length, and he printed the following:

"Last summer Mr. Fred Mather, Superintendent of the New York Fishery Commission, computed the eggs in one of our common pond sun-fishes. The extreme length of the fish, including the caudal fin, was 6½ inches, and its weight was 5½ ounces. The fish was captured on June 16, and was nearly ready to spawn; the weight of the ovaries was 1¼ ounces. The eggs measured twenty-eight to the inch, making 21,962 to the cubic inch. The displacement of the ovaries in water was a trifle over two cubic inches, and the number was estimated, in round numbers, to be 44,000—a most enormous number for so small a fish. This fish makes a nest in the sand or gravel near the edge of ponds or on shallow spots, and, according to Mr. Mather, it is the male fish which guards off intruders after the eggs are laid—a fact not known to ichthyologists, who study fishes after they have been kept in alcohol."

Adding 350 eggs to each thousand, for closest packing, and the total in this small fish would reach 58,000, a figure that I believe to be a more correct one.

Cold Spring Harbor, N. Y., April 30, 1890.

THE DETROIT WHITE-FISH STATION.

By J. H. Bissell, of Michigan.

Among the notable fish-cultural establishments of the United States, there is one of which very little has been said in the public press outside of the State. It is the White-fish Hatching-house of the Michigan Fish Commission, located at Detroit.

The commercial value of the white-fish very early attracted attention to its artificial culture, after it began to be inquired about and discussed whether any fishes could be advantageously cultivated by artificial methods. Even in the early sixties attempts were made at it—of course, crude and, in the main, unsuccessful—but still they were steps ahead and in the right direction.

It was not, however, until a Fishery Commission had been reluctantly granted by the Legislature in 1873 that efforts were made in the systematic way necessary to insure success. After two years of hatching by contract with a private individual, Orren M. Chase came from Caledonia, N. Y., and erected a humble building near the river front, in Detroit, on a rented lot. The house was about 20x50 feet, one story, and battoned. It was equipped with Holton boxes, which, in their day, were the best known apparatus for that work. A few years of observation on the working of the Holton box showed to the clear mind of Orren Chase a better way, one which has held its place for twelve years, and has not been improved upon yet—that is, the glass jar. There is not space here to go into the history of the evolution of Mr. Chase's idea; it was, like most inventions, a series of experiments which, step by step, led the seeker after truth, who steadfastly follows true principles, to a correct conclusion.

The glass jar furnished the eggs a regulated flow of water upward, which gives constant motion, keeping the eggs clean and preventing the dead or imperfectly fecundated ones from injuring the sound ones. Besides enabling the handling of a very much greater number of eggs with a given water supply and a given room space, by using the same water over and over; it allows two persons to take better care of 40,000,000 eggs than eight or ten persons could of 10,000,000. This house contained 212 jars, with a capacity each of about 140,000, making the aggregate of the house, if all were filled, of nearly 30,000,000. In 1883 the Legislature

furnished the means for erecting and equipping the present house. It is located at the corner of Champlain Street and Campau Avenue, in a nice residence neighborhood, and has often been mistaken for a plain church. Its dimensions are 40 x 80 feet, with a wing 38 x 55 feet. The main building is a single room full length and width, excepting a small office and bedroom partitioned off from one corner. The floor is of solid concrete. The water supply is from the city water-supply pipes in the adjoining streets, the connections being equal to five one-inch pipes.

The equipment was 312 glass jars of larger size than used in the old house, as they showed, by actual measurement and count for three seasons, an average of 156,000 to the jar, making a total for the house of 48,672,000 white-fish eggs.

This house was very carefully constructed with a view to maintaining an equable temperature. Outside of the studding it is sheathed with common boards, over which very heavy building-paper is placed, and the clapboards outside of that.

The space above the ceiling being quite large, is opened at both ends and covered with sloping boards; three apertures were left from this space connecting with the main room of the house, which are controlled by hatches.

The windows are all rather high, and on the inside are supplied with wooden slat-shades, which allow of regulating the light as desired. It is generally understood that no more light should be admitted than is necessary for the proper handling of the eggs.

Over the wing are large storage-rooms for the cans and other apparatus necessary about such an establishment.

The jars stand on frames about twelve feet high, placed the long way of the house, each frame carrying on its outsides rows of the jars one above the other. Within the frame are alternate feed-troughs for water supply to the jars and the wasteways into which the water flows from the

lips of the jars, there being a feed-trough and waste for each row of jars. The jar-frames were about twenty-three feet apart at one end, and they were connected by cross-tanks or troughs, by which the waste water from one side was carried across the house to the feed-trough on the other frame. The large cross-tank on the floor into which the water finally flowed, and in which the young fish were gathered in hatching-time, was connected with a long tank extending between the jar-frames, 48 feet in length, 4 feet wide, and 2½ feet deep.

In 1888 a hatching-house on the Little Traverse Bay was given up, and its complement of jars were accommodated in the Detroit house, making its number of jars 520 and the house capacity over seventy millions. In 1889 the house was remodelled within by the erection of two additional frames, taking out the central tanks, and making each frame carry four tiers of jars on each side. The number of jars was increased to 1,025, giving the house now a capacity of carrying 150,000,000 white-fish ova. By the new arrangement the storage-tanks for the young fish, four in number, are placed in the wing, or tank-house, the storage-tanks there being connected by siphons to the collecting-tanks in the main or jar-house, for transferring the young fish.

This house is supplied with a steam-boiler and pump. The boiler answers the double purpose of heating in extremely cold weather, and furnishes power for the pump in case of accident to the water supply occasioning a stoppage of water from the city mains; the pump will lift the water from the tanks on the floor to the upper trough, and use the same water over and over as long as needed. The house is furnished with a stove, and that most necessary adjunct for ventilation—an open fire. Every hatching-house ought to be provided with a good, large, open fireplace to keep it dry by proper ventilation. There is no provision that can be made for the comfort of the men equal to that.

The present season there are about 900 jars filled in this house, the take of eggs in Detroit River in November last not being sufficient to fill the jars. However, with the average hatch, the house will turn out about 121,566,000 white-fish fry, to be planted in April and May, 1890, in Michigan waters.

The Detroit hatching-house, as constructed and equipped in 1883, cost about $6,500; its subsequent improvement and alteration, with increased apparatus, about $4,000 more. How such an establishment is stocked with eggs, as it requires nearly one hundred solid bushels, and how its millions of product are planted, it will take another article to tell.

ON THE DESIRABILITY OF THE ESTABLISHMENT, OF GREAT PUBLIC AQUARIA IN THE UNITED STATES.

By William P. Seal.

The beginning of the development of great public aquaria in the United States will undoubtedly be hailed by anglers, fish-culturists, biologists, and as well by the general public, as a "consummation devoutly to be wished." Some past experiences in this direction offer but little encouragement if not positive discouragement, in this direction. But, as in all advances in human knowledge, there is an experimental stage of development by which, through repeated failure, there comes finally a general knowledge of the conditions required for success. In the case of fishes, living in another element, the difficulties in providing them with suitable conditions are apparently greater than with land animals. There is the necessity of providing for fishes in an artificial condition an abundance of oxygen, or air, the amount of which, in suspension in water, from various causes, is exceedingly variable, therefore requiring an artificial system of aeration.

There is, no doubt, a more rapid accumulation of carbonic acid gas and other deleterious gases in the water. There is the difficulty of providing suitable food. There is also the delicate nature of fishes to contend against; the fungus growths which infect them wherever scratched or bruised, or in weak or diseased condition, and the numbers of parasites infesting them, some of which are very destructive.

And yet, upon a fair examination, it may be said that, in the present state of our knowledge, the handling of fish, or the keeping of them in captivity, is probably attended with but little, if any, greater mortality than is usual in the keeping of any but domestic animals. And even among domestic animals the ravages of epidemics are frequent, and the unaccountable deaths occur at times in quite as great a proportion as ever occur among wild animals in captivity.

The fact that some species of animals are more amenable to the conditions of captivity than others, and that the same is true of the individuals of a species, is, of course, generally understood; but it is not usually recognized in such a way as to make the knowledge of practical value by providing for each the conditions necessary for their comfort and happiness. We recognize this necessity in providing for our pet animals or our stock, because this is a matter that comes home to the individual; but in our aggregations of animals for purposes of exhibition or observation, through a false economy generally, or, perhaps, often through ignorance of the real necessities (for such work is often taken up by inexperienced persons), we provide what may be called comfortable prisons for the confinement of animals whose natures chafe at all restraint, and whose natural instincts are thus wholly checked and thwarted; the sexual instinct, that of migration, hibernation, the variation of food and temperature, and, in the case of certain fishes, perhaps, a necessity for a change of character of water—fresh, salt, or brackish, as required—and the activity possible in greater space, etc.

When we consider that we may confine the smaller species of fishes, such as the gold-fish, minnows, shiners, sticklebacks, darters, and others, in ordinary aquaria, which, owing to the small size of the fish, give them considerable room, and have them to live contentedly, spawn naturally, and live in every respect, apparently as happily as in their native waters, it becomes apparent that when we provide conditions proportionately adequate, we may expect the same results with any of our fishes. The desirability of the accomplishment of such results needs no argument to the mind of the fish culturist. It is, in fact, the only way in which we may obtain a knowledge of the habits of many of our fishes, hidden as they are from our view in the depths of the waters. To the biologist the opportunities afforded for investigation by such means are very great and of increasing necessity. To the general public, as a means of recreation and education in a branch of knowledge in which the ignorance is very great, but in which the popular interest is equally great, the value of great public aquaria would be well worthy a general popular support.

It is quite apparent that in most of the attempts heretofore made to establish aquaria in the United States, the conditions established were such as from our present knowledge we can say were inimical to any permanent success.

Of course, it should be understood that we are at present but on the threshold of our knowledge in this direction; but we may claim that there are certain great principles underlying success in the keeping of living things in healthy and happy condition, and that a violation of these plain requirements invites certain failure.

From a standpoint of practical experience established by years of observation, in accordance with these principles, and in view of minor results actually achieved, we may now confidently proceed to the successful establishment of great aquaria.

A brief explanation of these fundamental principles may be necessary for a proper understanding of the subject from the writer's standpoint. It is well known that many animals, when held in restraint, exhibit all the symptoms of fear, grief, rage, etc., and frequently refuse all food, and pine and die. Many birds will beat themselves to death on the wires of their cages. All such restraint, evidently involving great suffering, is necessarily cruel and objectionable from that standpoint alone. From a financial standpoint it is altogether objectionable, because the great mortality resulting from keeping animals in an unhealthy or unhappy condition makes the expense of maintenance of great collections of animals of any kind too great for financial return for private enterprise, or for popular support for educational purposes.

The attempts heretofore made in this direction in the United States, as well as the known financial aspects of the establishment of aquaria abroad, and of zoological gardens as well abroad and at home, justify the statements herein made. There is nothing to be gained by ignoring them. Whatever advance is made in the future must come from a recognition of the general principles herein sought to be explained. The establishment of the National Zoological Garden at Washington, under the direct management of a naturalist who has studied animals in their natural homes and haunts, instead of in books, promises to make a departure in such work in many respects, in a closer approximation of natural conditions, as far, at least, as the limited extent of space provided will allow. A much greater park, such as the entire Rock Creek Valley would make, affording all the room and variability of surroundings necessary to the contentment of animals of widely divergent natures, would only be worthy of so great a country.

In the establishment of great aquaria, when the subject assumes an importance deserving consideration, it will be

found that to follow in the methods of the past will, as heretofore, be to invite failure. The question of, in a measure at least, imitating natural conditions underlies all success. There can be no further question of its necessity, whether with aquatic or terrestrial animals. In regard to the mere question of space, it has been found with fishes that those which it is impossible to keep in an aquarium of a certain size, will live comfortably in one considerably larger. This has been tested in the cases of a number of species very difficult to keep, and it may be emphatically stated as a principle that as the area or space allotted to animals in captivity increases, the symptoms of depression will decrease and the difficulties in keeping them diminish in a like ratio.

In the question of fishes, the question of the purity of the aquarium is one of the greatest importance. The oxidation of metals, the decomposition of paints, and the galvanic action resulting from the use of more than one metal in salt water, are all inimical to success. The further injurious effects of the decomposition of organic matter, the food or excreta of fishes, etc., in combination with the first-mentioned elements of injury, still further increase the difficulty. Thus the necessity for purity or freedom from injurious chemical action in tanks or circulatory apparatus is one of the principles upon which success depends.

It has been satisfactorily demonstrated that an abundance of light, and at least some sunlight, is necessary for the healthy development of aquatic plants. This is probably true of almost all living things. The healthy development of plant-life in its turn has its beneficial effect on the development of animal life, aside from the direct benefits conferred by the action of sunlight in liberating oxygen. Even where animals live in a state of semi-darkness, concealed among stones or plants, the air or the water penetrating to their homes is revivified by the potent influence

of sunlight. The establishment of an aquarium therefore demands, as one of the conditions of success, an abundance of light, the same conditions, in fact, necessary to life in the pond. The closer we approach this ideal, the greater the success will be.

The establishment of a marine aquarium at Washington by the United States Fish Commission has furnished the means of making many interesting observations, and has practically demonstrated that it is possible to maintain marine aquaria away from the sea without very great difficulty and without greater mortality, probably, than is usual where the water may be pumped directly from the sea. The chief difficulties are in the transportation of fishes from the sea without injury, some of them being of very delicate nature. This is more easily accomplished at a time when the temperature is moderate, being neither at one extreme nor the other. The control of temperature in the aquarium, owing to our extremes of heat and cold, is a matter of some difficulty, but must be overcome as an element of success. The more nearly we can approach an equalization of temperature, the more satisfactory will be the results, no doubt.

The Washington Marine Aquarium is built in a greenhouse-like annex to the central station of the United States Fish Commission. This style of structure affords the necessary light. Twenty-four aquaria, of from sixty to seventy five-gallons capacity each, are arranged to form a gallery in a cavern or grotto built in imitation of rock, which is lighted wholly by the daylight passing through the water from above; 6,000 gallons of water are used. This is pumped from a brick reservoir outside to a tank at an elevation of about forty feet, from which it descends under the resulting pressure—about twenty pounds—into the aquaria through very small glass nozzles, thus effecting a most efficient aeration. The materials of construction of aquaria, reservoir tanks, circulatory apparatus, etc.—

everything with which the water comes in contact—are hard and soft rubber, wood, slate, glass, and brick, nothing whatever of an injurious character. Most of the loss of salt water is supplied by water made sufficiently salt by the use of sea salt. As a result of the abundance of light afforded, the slate backs and sides of the aquarium, and the bare stones placed in them, are being gradually covered with a dense growth of algæ developed directly from the spores of algæ brought from the sea, just as it is seen developing on sea-walls and rocks, something, perhaps, altogether unknown under the usual unfavorable conditions. The observations of the habits of fishes afforded by these aquaria have been of great popular interest, while the advantages of the observations to the general work of fish culture in opening up new avenues for experiment in practical work may prove to be considerable.

Some recent statements concerning the breeding habits of the common sunfish elicited the fact that the knowledge of the subject is not positive. Referring to this, Prof. Theodore N. Gill was led to say to the writer that "it is a shame that we know so little of the habits of our commonest fishes." To which might be pertinently added, it is a shame that the facilities afforded for observation of fishes are so limited.

It is to be hoped that a great aquarium may be developed in connection with the work of the United States Fish Commission, inasmuch as in addition to its practical usefulness to that organization, and its great popular interest, the experience there afforded will be of general public benefit in affording a sure basis of practical knowledge upon which the great cities of the country or institutions of learning may draw when they decide to take up such work.

GRAYLING IN MICHIGAN.

BY JOHN H. BISSELL, OF MICHIGAN.

Having been asked some questions about this rare member of the salmon family, I assume that the subject may be of interest to your readers who are anglers.

Where is the Michigan grayling found to-day? Any one really wishing to know may take a map of Michigan to follow my answer. Begin at a point on Saginaw Bay at the mouth of Saginaw River, and draw a line west by southwest to the mouth of the Muskegon River, on Lake Michigan, and all of the grayling waters are to the north and west of your line. Let us start again at the same point on Saginaw Bay and fo low the coast northward towards the Straits. The first stream of any size is the Rifle River. I am informed upon good authority that grayling have been found within the past three or four years in the Rifle and its tributaries. I am not sure that the appearance of the fish there is of so recent a date as my informant believed, but with a fairly extended knowledge of such matters I had never before heard of their being there. There is no reason why they might not live and flourish in the Rifle, as its waters are suitable.

The next river to the north is the Au Sable, where grayling have been known since 1841. This is one of the most famous of fishing-grounds. While to those who fifteen years ago used to kill from one to two hundred grayling a day, this river seems to be "fished out;" it still furnishes fair sport to the humble philosopher who is satisfied with a moderate reward for his day's work.

To the north, in Presque Isle, Montmorency, and Alpena counties, is the Thunder Bay River, with its numerous branches of fine water. I have never heard of grayling in any of them, but from their situation and the character of the waters, I should want good proof that grayling were not to be found in the head-waters of this system. This is des-

tined to be a great brook-trout region, as the railway facilities now permit its being stocked.

The Pigeon and Sturgeon rivers, flowing nearly north into the Straits of Mackinac, at Sheboygan, are well stocked with grayling.

From the Straits around to the head of Grand Traverse Bay are the rivers and brooks which contained brook-trout before any were planted by the State. Originally there were grayling in all these streams, but for twenty years or more these fish have been so scarce here that they have really ceased to be grayling streams. South of the Boardman River, which flows into Grand Traverse Bay to our imaginary line, is a distinctively "grayling country." The main rivers are the Manistee and the Muskegon, the whole region spoken of being drained by their tributaries, except two much shorter streams, the Pere Marquette and White rivers.

This comprises the grayling region of Michigan. There is one stream on the Upper Peninsula, about twenty miles from Houghton, where grayling are found—the east or north branch of the Ontonogon River, crossed by the D. S. S. & A. R. R.

The rivers and their branches above mentioned are most conveniently reached from the interior of the State by the Michigan Central Railway (Mackinaw Division) for the eastern and northern, and by the Grand Rapids, Indiana, & Chicago and West Michigan for the western streams.

Over a large part of the territory described the grayling has beyond question become very scarce, mainly by reason of the indiscriminate fishing of the citizens, lumbermen, and hunters, as well as fishermen from other States. The lumbermen and hunter have speared and netted and used dynamite for meat during the close season. The others have killed more than they could use. The running of logs has undoubtedly done great injury to the grayling by the disturbance of their spawning beds, as they use the

channel of the main stream, not seeking the brooklets and shoals, as the trout usually do. Still there are grayling yet to be had, and most delightful sport it is to capture them with delicate tackle.

Nothing has been done by the State for preserving the grayling beyond experiments to determine to what extent the grayling can be bred in captivity like the brook-trout. The experiments have not been successful. Grayling kept in stock-ponds have gone for several seasons without showing any signs of spawning. The experiment is now being prosecuted in a large wild-pond—that is, a portion of a natural grayling stream screened off, where the fish remain in entirely natural conditions of bottom and shade without any molestation. Unless the approaching spawning season turns out better than 1888 and 1889, I think the State Fishery Commission will conclude that the only feasible way to increase the grayling will be to establish one or more camps on the Manistee, or other stream where spawners can be secured, and handle the fish there, taking the eggs from fish caught in spawning season, as is done with white-fish and shad, and hatching in shad-boxes or some similar appliance, in the river, turning loose the fry intended for the stream where operations are conducted and transporting to other localities in carrying-cans.

There is no doubt that if nothing is done to save them they will become practically extinct in the next five or ten years.

There are some inaccessible places where they will undoubtedly linger many years; but they are or will become practically extinct when they are so few and so scattered that their pursuit no longer furnishes reasonable sport to a reasonable and modest angler.

The grayling waters of Michigan are cold, clear, rapid streams, flowing through bottom-lands and sand regions, and in no case, to my knowledge, over rock formations, an alternation of the most beautiful ripples and pools.

EXPERIMENTS IN THE IMPREGNATION OF PIKE-PERCH EGGS.

BY HERSCHEL WHITAKER, OF MICHIGAN.

The eggs of the wall-eyed pike, after having been for some time in water, measure about two millimeters (about 1-12th of an inch) in diameter. The egg has an enveloping membrane (or zona radiata) of the usual form. Outside this is a second thinner membrane, which wrinkles and stains more deeply in the hæmatoxylin than does the inner zona radiata. The eggs are very adhesive, and it is to this outer membrane that the adhesiveness is due. There is probably also a third membrane within the zone, but this has not been determined with certainty. Within these membranes is the yolk, having a diameter of 1.4 mm. (about 1-18th of an inch). The yolk is spherical, and in one side of it is imbedded a spherical oil-drop having a diameter of .8 mm. (about 1-31st of an inch). The oil-drop causes the surface of the yolk-sphere to protrude to one side. The oil-drop being lighter than the yolk, is always turned upward, so that in looking at the egg from above the oil-drop appears to be in the middle of the yolk, while in looking at the egg from the side the oil-drop appears to be at the top of the yolk.

I shall speak of that pole of the yolk in which the oil-drop is imbedded as the upper pole, and of the opposite side as the lower pole. A line drawn about the yolk, half way between these two poles, will be spoken of as the equator. When the egg is at rest the lower pole of the yolk rests upon the egg membranes, so that the space which separates the yolk from the zona is altogether above and at the side of the yolk and oil-drop. This space may be spoken of as the breathing space. Surrounding the yolk and oil-drop is a layer of protoplasm, which forms an investment for them and separates them from the water in the breathing space.

This layer of protoplasm is extremely thin over the greater part of the yolk, and is tightly stretched over the protuberance formed by the oil-globule. It is not, however, uniformly thin, but in one place has a disk-shaped thickening. This thick disk of protoplasm (germinal disk) is concave towards the yolk and convex on its opposite side, and is fitted like a saucer against one side of the yolk. Its position is such that its center is upon the equator of the yolk, so that in looking at the egg from above one sees the edge of the germinal disk. Outside the disk the layer of enveloping protoplasm is so thin that it cannot be easily seen except by the use of reagents. So long as the yolk is within this enveloping layer of protoplasm it is entirely transparent and colorless. If the enveloping layer be ruptured so that the yolk passes out and comes into contact with the water, it becomes instantly opaque and of a milk-white color.

The foregoing description applies to the egg after it has been some time in the water. As the egg leaves the female the egg membranes are not separated from the yolk by a water-filled space, but are everywhere in close contact with the layer of protoplasm which invests the yolk. When the egg is placed in water, the water passes rapidly through the egg membranes and accumulates between them and the yolk. In this way the membrane becomes gradually separated from the yolk by a water-filled space —"the breathing space."

By this passage of water through the membranes they become tightly stretched and tense, so that an egg which at first feels under the finger like a piece of soft putty, becomes hard to the touch by the absorption of water, and feels like a shot. This "filling" of the egg takes about two hours.

The foregoing account of the structure of the egg is sufficient to an understanding of the mechanical arrangements that it presents.

As it seemed likely that for some reason a large per cent. of the eggs failed to be impregnated, my attention was first directed to determining the first differences between impregnated and unimpregnated eggs.

In order to determine the question with certainty for this particular animal, the following experiment was tried (quoted from note-book):

APRIL 16, 8:45 A.M.

After washing the surface of the body of a female fish in the region of the external opening with weak acetic acid, in order to destroy any spermatozoa, the eggs were stripped into dishes containing water. Into one dish milt was immediately stripped; the other was left without milt. These were marked lot 1 and lot 2 respectively.

Lot 1. Examined at 1:45 P.M. (the eggs having been kept in a cold room), and found segmentation going on. The germinal disk is divided into either two or four cells.

Lot 2. Examined 8 A.M., April 17th, twenty-four hours after impregnating lot 1. The eggs were firmly set in a mass on the bottom of the dish. One hundred taken at random were examined with following results:

Showing normal germinal disk without trace of segmentation.................... ...	82= 82%
Showing abnormal germinal disk with possible traces of first or second segmentation....	4= 4%
Injured by rupture of protoplasmic investment of yolk, so that yolk had escaped and egg had turned white..............	14= 14%
Total	100=100%

This experiment was afterwards repeated without, however, counting the eggs, and always with the same result.

Segmentation of the germinal disk is, therefore, the first easily recognized sign of impregnation.

In order to determine the percentage of unimpregnated eggs among those taken by the men and ready for ship-

ment to the Detroit hatchery, the following counts were made:

April 17th, 1 P.M., 252 eggs taken at random from a tub, after stirring the eggs in the tub, were examined with the following results:

Segmented normally (i.e., impregnated)........	141= 56%
Unsegmented, normally (not impregnated)......	26= 11%
Injured by escape of yolk (white eggs).......	85= 33%
Total..................................	252=100%

The eggs marked as unimpregnated were set aside, and were found to be still unsegmented after twenty-four hours.

This was several times repeated on other lots of eggs, with similar results.

It shows that about 33% of the eggs are injured mechanically by the rupture of the protoplasmic investment of the yolk, while only about 11% perish from lack of impregnation. Even superficial examination shows that in nearly every case this rupture of the yolk takes place over the oil-globule. A consideration of the mechanical arrangement of the parts of the eggs shows that this is its weak spot.

In the natural position the yolk sphere lies with its lower half against the egg membranes. These membranes, therefore, support this half of the yolk, surrounding it as if it were resting at the bottom of a cup.

The upper half of the yolk is, on the contrary, not of the same form as the investing membranes; its spherical surface is interrupted by the protruding oil-globule.

The result of this arrangement is that when any pressure is brought to bear on the egg membranes, so that the space within which the yolk lies is reduced, the yolk is able to resist this pressure by fitting itself against the egg membrane at every part of its surface except over the oil-

globule. The strain, therefore, comes on that part of the protoplasmic investment of the yolk which covers the oil-globule, and here it bursts. In almost every case the white spot which indicates the rupture of the yolk investment makes its appearance at the oil-globule, usually at its equator.

Owing to the fact that the eggs are adhesive, it is the practice of the men in taking them to stir the eggs with the hand. By this means they detach the eggs that have adhered to the sides of the pail, and separate from one another those that have adhered together in bunches. This stirring takes place shortly after the eggs are placed in the pail and before they have filled with water. In this condition the space between the membranes and yolk is either absent or it is so small that it forms rather an aid than a hinderance to the bursting of the yolk investment.

It is therefore desirable to find some means of handling the eggs so they will not adhere to the vessel in which they are placed, and so they will not adhere to one another to such an extent as to render it necessary to separate them by the hand.

As to the first point, the men handling the eggs have found that they do not adhere to an ordinary unpainted wooden pail which by use has become rough inside, while they do adhere to the galvanized iron pails now in use. I have observed that while the eggs adhere strongly to glass, they adhere but slightly to cloth. I have no doubt that by the substitution of wooden pails for metal this difficulty will be overcome.

It is likely that a metal surface might be oiled or otherwise so prepared as to prevent the adhering of the eggs.

With regard to the second point, it has been found that if water be added to the eggs *very slowly*, while at the same time they are kept in motion by rocking the containing vessel, they do not then adhere to one another. This is true whether or not milt be mixed with the water.

Two lots of eggs were taken from the female and placed in two similar glass dishes, and to one milt was added. Water was then gradually added to each lot with continual agitation of the eggs by rocking the dishes. This was continued until the dishes had been filled with water and until the eggs had "filled." In neither dish did the eggs adhere to one another or to the dishes. Eggs taken from either dish and transferred to another dish containing a larger quantity of water adhered at once.

In order to test the effect on the eggs of not introducing the hand, about two quarts of eggs were impregnated in a galvanized iron pail. The water was added slowly and the pail kept in motion. The eggs did not adhere to one another, but adhered in a layer one or two eggs thick over the bottom and sides of the pail. Without distributing those eggs that had adhered to the pail, those in the center were removed, and 154, taken at random, were examined with results as follows:

Injured	15=	10%
Not impregnated	0=	0%
Impregnated and afterwards segmented	139=	90%
Total	154=	100%

A second trial resulted as follows:

Injured	12=	7%
Not impregnated	2=	1%
Impregnated	165=	92%
Total	179=	100%

An attempt was made to determine the result of using a wooden pail and taking account of all of the eggs, whether they had adhered to the pail or not. About a quart of eggs was used, and they were examined shortly after being impregnated. They had not adhered to the pail nor to one another, and the percentage of injured eggs did not appear to be more than five. Unfortunately, the eggs

were afterwards mixed with others and the whole lot roughly handled before an opportunity was had of making a careful examination of them. The suspension of operations shortly after this prevented a repetition of the experiment.

It is to be noted that when the eggs are permitted to adhere to the pail and to one another, so that the percentage of those injured is large, the percentage of those impregnated is also greater. The same method of handling that reduces the percentage of injured eggs reduces also the percentage of those unimpregnated.

From the two causes about 45% of the eggs examined could never have developed. Since the percentage of eggs lost during the present year is estimated at 40, there remains 15% still to be accounted for.

A lot of eggs, 45% of which are dead, requires much more handling than would be the case if all were sound. Such a lot of eggs also invites the attacks of the fungus which spreads from the dead eggs to the living ones, and is likely to kill those in turn.

In such a lot many living eggs become clogged among the dead ones, and are probably either smothered or poisoned.

In short, if the loss of eggs which takes place at first from mechanical injury and lack of impregnation can be stopped, it is fair to expect that the subsequent loss will be much reduced.

THE STURGEON; SOME EXPERIMENTS IN HATCHING.

By Hoyt Post, of Michigan.

Of the numerous fish which abound in the great lakes and deep rivers that surround the State of Michigan, one of the most valuable, commercially, is the sturgeon. Nearly every part of it is utilized in some way; the flesh

is eaten, either fresh or pickled, and when dried and smoked is sold as halibut. The bladder, which is large, is converted into isinglass and glue. The skin is sometimes tanned, and even the dorsal cord is cut and dried and used as food. Every bit of waste is tried out for oil. The head is cooked and eaten by the Indians. The roe is much the most valuable part of the fish. In the full-grown fish it weighs from fifteen to forty pounds and upwards, and at times constitutes nearly one-third the weight of the fish. From this caviare is made. The eggs are rubbed with the hand through a sieve until they are separated from the connecting membrane, and then a fine German salt is added, and the product thoroughly stirred with the hand and drained. It is then dried and packed in kegs for shipment. It is eaten as a relish and used as a substitute for meat in sandwiches. It is quite rich, and has a decided fishy, oily, and salty flavor. It is highly prized by the Russians, and is said to be much used in fast seasons in Italy, Greece, and Turkey. It finds a ready market in this country in St. Louis, Sandusky, New York, Philadelphia, and Pittsburgh.

The sturgeon is taken largely in pond-nets, and a good many are caught by set lines in the narrow, deep channels that traverse the St. Claire Flats, near Detroit. A strong line is stretched upon stakes on either bank of these channels, and from this depend many shorter lines to which are attached large hooks which rest on the bottom. The sturgeon, in rolling upon the bottom, becomes entangled in these hooks and is captured with a gaff.

The Michigan Fish Commission last year tried the experiment of artificial propagation of this valuable fish. A station was selected at Algonac, a small village on the St. Clair River, where a caviare factory was in operation. The fish that are handled there are caught principally in the channels of the St. Clair Flats by the Indians, Canucks and half-breeds in the manner above described; they are

towed by a tug in a covered yawl from the places of capture —a distance of from three to ten miles—to the station at Algonac.

In the early part of June a pen about forty feet square was made adjoining the factory, by means of an old seine, between the bank of the river and some old spiles which had once been part of the dock; this pen was from one to five feet deep, with sandy bottom, and a swift current of clear water swept through it.

On June 6th six females were placed in this pen, and on the next day eight males, and on the 18th of June ten more were added; but they did not do well in confinement, on account of the injuries they had received from the gaff when captured. On June 17th the fish commenced dying, and six were taken out, when it was found the eggs had become hard and baked, and were almost the color of gold. The milt of some of the males had shrunk to almost nothing, and in others appeared to have ripened somewhat. On June 27th the remainder of these fish, having become very weak, were all taken out. Up to this time only six spent fish had been taken, though upwards of 4,000 were handled; and none were captured that were ripe except two that were taken on the 20th nearby, in the North Channel. Of these two, one was nearly spent and the other was about half gone. The fish were but just alive. A male that was taken in the same catch was cut open and the milt-bags crushed into a tub containing about six gallons (say four inches deep) of water, and the half-spent female was laid across the tub and split next to the vent, and the eggs allowed to fall into the milt. The tub was then kept in motion in the water for three and one-half hours, until the eggs became pretty well separated and ceased sticking. Two tubs were used, and one man handled each tub, standing in the water above his knees. There were probably in all about 40,000 eggs, of which perhaps one-half were thoroughly separated and fertilized.

The fertilized eggs measure about forty-nine to the square inch, while the eggs in caviare go about sixty-eight to the square inch.

These eggs were taken from the tub and put into about a dozen Seth Green shad-hatching boxes and placed in the river, harnessed together and attached at the upper end to the dock and anchored at the lower end, so as to float freely in a swift current of clear water of about twelve feet in depth. The temperature of the water was about fifty-nine to sixty-one degrees. For two days the eggs appeared to be doing well, but on the third day a fungus began to appear and spread rapidly, and thereafter it was difficult to tell the good eggs from the bad ones; on the fourth day the good eggs showed a brown side with a yellow streak through it; on the fifth day the young fish could be seen in the egg; on the seventh day motion could be detected, and on the eighth day hatching commenced, and was complete on the ninth day.

The number hatched was estimated at from eight to ten thousand, and they were released in the river at the place of hatching, on July 2d, the twelfth day after they were taken.

The eggs are a rich, dark bronze color, and are very tender, so that they will not bear hard stirring or rough usage; this necessitates great care and patience in the first handling. The milt seemed to form a heavy coating on the eggs that were fertilized, which would stick the egg to everything it came in contact with. The adhering of good eggs to each other did not seem to hinder hatching, but wherever a dead egg came in contact with good ones it destroyed them all; and many good eggs were lost in removing the fungused ones.

Afterwards, about July 5th, eighteen sturgeon—twelve females and six males—caught in nets, were procured at La Butte's Point, in Canada, above Detroit, and were towed by row-boat in a crate about ten or twelve miles to a

large fish-pond made of sheet piling, in Detroit River, at the Fort Wayne fishery, below the city of Detroit. This pond was in clear water, in the current, and detached from the shore, with soft bottom and of an average depth of about six feet. The fish arrived in apparent good condition. One small male, supposed to be about four years old, was killed to ascertain the growth of the milt, which was found to be well developed. A small platform or slide was erected at one end of the pond, and a small seine was used to handle the fish. They were carefully handled twice a week for more than two months without any success. No eggs were taken from them.

Finally, upon opening a female, the eggs were apparently blasted. The milt of the males also appeared to have dried up or shrunk away. A male and a female were left in the pond until October, and at that time, when taken out, the female had shot her eggs, and appeared in good shape, with new eggs forming.

The facts stated in this paper as to the experiment in hatching sturgeon eggs are principally derived from Mr. Aaron W. Marks, the assistant superintendent in charge of the work. He was formerly a pupil of Seth Green, and assisted him in about the year 1876 in, perhaps, the first successful hatch of sturgeon in this country. That hatch was made at New Hamburg, on the Hudson. The number of eggs taken was about 200,000, and they were taken from a single fish. The hatch was about 140,000. The manner of treating the eggs was about the same described above, as adopted at Algonac last year.

Further experiments in this line will doubtless be made in Michigan the coming season.

THE ORIGIN OF ARTIFICIAL FISH CULTURE IN THE UNITED STATES.

By E. D. Potter.

I had intended on this occasion to speak upon the subject of propagating the different kinds of fishes with which I have had some experience, and the earlier and the improved methods which from time to time have been adopted in bringing that art to the perfection which it has attained; but, unfortunately, at Christmas I was attacked with that malady which has held so many in its "Grippe" in the Old as well as in the New World, disqualifying them for labor in the ordinary avocations of life. I have suffered from its effects for the last four months, most of the time confined to my house.

I offer this as an apology for not carrying out my original intentions. However, as but few persons now living, beside myself, since the death of the lamented Dr. Garlick, who were present at the birth of the first fish artificially produced in America, it might be interesting to some of the gentlemen of this Society to hear some account of the first fish artificially propagated upon this continent.

In the winter of 1853 an account was published in the *National Intelligencer*, of Washington, of the experiments of two unlettered fishermen, Gehin and Remy, of the Vosgen mountains, in Lorraine, then a province of France, in which they had succeeded in the incubation and hatching of a great number of the fishes of that region. This account fell under the notice of Dr. Theodatus Garlick, of Cleveland, who at once entered into the scheme of making experiments in the artificial propagation of the brook-trout. (*Salmo fontinalis.*) A few miles from Cleveland was a deep ravine through which passed a small, cold stream, fed by several cold springs issuing from the adja-

cent banks. Across this ravine was thrown a dam, raising a deep pond covering over half an acre of ground. The next thing was to procure the parent fishes. An expedition was started to Port Stanly, in Canada, and another to Sault Ste. Marie, in Michigan, both of which were successful, procuring in all some fifty trout of good breeding size. These were placed in the pond in June, 1854. A breeding-place was leveled off at the head of the pond, covered with gravel. I spent the season in Cleveland, and visited the pond daily with Dr. Garlick, and found the fish doing well. About the first of November, on visiting the pond, we discovered two small trout making a spawning bed, and in the course of ten days the bed was covered with fish. The next thing was to prepare hatching facilities. A small cabin was erected over one of the largest springs, about ten feet square. Six boxes were procured about one foot square. There was over a dozen feet fall from the spring. These boxes were terraced from the spring down, with a spill from one box to the other, guarded by a screen filled about two-thirds full of fine gravel, and the hatchery was complete.

I shall never forget the expression of the countenance as he lifted the first pair of gravid fish from the pool. The usual operation of stripping the fish and fecundating the eggs was performed, and the eggs gently spread over the gravel in box number one, and the water was let on. In the same way the boxes were all filled and the work was done. A padlock was placed on the door, and the Doctor was happy. We visited the hatchery often to remove unfecundated eggs, of which very few were found. On visiting the hatchery, about the latter part of January, the eyes appeared in the eggs, and about the first of March, 1854, on visiting the works, there lay prone on his side on his gravelly bed the first baby fish artificially propagated on this continent. Then followed the hatching till the boxes were alive with the young trout. Dr. Garlick soon after wrote

a full account of his methods, and the success attending his first experiments was widely circulated, and soon Seth Green, of New York, Samuel Wilmot, of Canada, Nelson Clark of Michigan, and others, all making improvements of Dr. Garlick's process, until fish propagation has become a national industry, and, fostered by adequate appropriations, is furnishing cheap and wholesome food for millions of people.

DANGER TO FISH-EGGS IN TRANSIT.

By Fred Mather.

In a note to *Shooting and Fishing* I made use of a term that seemed to demand explanation; and while I do not intend at this time to say anything about methods of packing fish-eggs for foreign shipment—a thing that I have had much to do with—I wish to say something about their condition on receiving them. The remark alluded to was: "I have noticed that foreign eggs often appear good, but [as often] hatch deformed fish," etc. The bracketed words should have gone in. This requires explanation, because it may appear to reflect on the fish culturists on the other side. In former years I have reported eggs from Europe to be good because they were not dead, and my reports of loss of eggs and fry have, on some occasions, been out of all proportion to the after-mortality. The reason of this lies in the fact that an injury to a living thing is not always fatal (a notable instance of this may be found in the first chapter of "Tristram Shandy"), and fish-eggs may be injured in transit by heat, concussion, or a lack of moisture, so that the embryo will come into the world only to die.

When eggs have come across the sea I now report that a certain number appear to be good, reserving a positive decision until the eggs hatch and the fry begin to take

food. High temperatures, lack of moisture, and concussion are the principal, if not the only, causes of injury to the embryo.

It is my present opinion that concussion is more immediately fatal than a high temperature; it kills within a few days. Lack of moisture is shown at once by indented eggs, and upon the degree of indentation rests the damage. I have experimented with such eggs, and have found that those only slightly indented have produced fairly good fish, while others somewhat dryer did not. A high temperature on eggs of *Salmonidæ*—and it is of these that I speak—makes weak embryos, if they live to break the shell. They hatch head first, and all fish culturists know that such fish have a small chance for life, or, that they have not strength enough to straighten from the coil in which they have been, and are "whirligigs," spinning round in one direction at every effort to move. These die of starvation because they cannot swim.

A lot of salbling eggs received from Germany a year ago looked first-rate, but one-fifth of the embryos had not strength enough to straighten after hatching, the cause being a high temperature through lack of ice in the packing, which was my own "wet" method. This is the main risk in this method, while the "dry" packing is all risk. I know by letters received that many eggs are prematurely reported to be good, *i. e.*, because they are not dead, and that the injury to an indented egg is not taken into consideration by some fish culturists; hence I write of it, although aware that there are men at this meeting who understand this source of injury to a fish-egg, but it is not for them that this is written. Another result of high temperature, *en route*, is a softening of the egg, either the outer covering or some part beneath, and these embryos hatch, but do not live to take food.

I have seen soft trout-eggs which seemed to have cast one

skin and retained a thin one. These were always eggs that had received a high temperature some time in transit, and the embryos only hatched to die.

To the journal named I wrote the following for its issue of April 3rd, 1890: "In consequence of an unguarded expression I have been compelled to write a treatise on fish-eggs in order to save myself from appearing to be unfair to the fish culturists of Europe, and also to explain why the eggs of brown trout sent by the *Fishing Gazette*, of London, to *Shooting and Fishing*, in my charge, were not reported to be in as good condition as they looked to be when opened. When I receive eggs from Europe that look good, a doubt about their history in transit arises, and I have learned to be careful in reporting their condition, unless such as may have turned white. When they hatch we can judge of chances of life. I can now say that the eggs sent by Mr. R. B. Marston, from the hatchery of William T. Andrews, of Guilford, England, have produced a fine lot of fish. Of the original 10,000 we found about 1,000 dead—notes not handy, and can't be exact—and sent, as per your order, 3,000 to Mr. Peter Cooper Hewitt, Ringwood, N. J. The remainder will produce fully 5,500 strong fish up to the feeding point."

Deformed fish seldom live, and those which spin round and round never do. These deformities are the result of injury to the egg, and cannot be detected until the shell is broken; hence I will be careful in future in reporting that eggs are really good after coming across the sea, because my superior officers naturally expect a certain number of good fry from each thousand reported good eggs.

Cold Spring Harbor, N. Y., May 1st, 1890.

EXPERIMENT IN TROUT HATCHING AND REARING IN ARKANSAS.

By P. P. B. Hyerson, President Mammoth Spring Fish Farm.

The Mammoth Spring Fish Farm Company was organized and incorporated December, 1888, and received their first 100,000 brook-trout eggs January, 1889, and their next 125,000 of brook and rainbow trout, February, 1889. The eggs came from Gilbert, of Plymouth, Mass., and were packed in wooden cases of 50,000, with moss and ice, the temperature of the weather being 50 to 60 degrees here. The eggs came through by express in good order, and in ten days from receipt of same—January 21st and February 1st—they began to hatch. The percentage of loss in hatching these 225,000 was about 20 per cent. Gravel was used instead of wire. The young fry appeared healthy and thrifty, and at six weeks old they began to throw off the sack. However, at thirty days old our hatchery met with an accident from an oversight of those in charge. The water was allowed to come into the hatchery from the spring without being filtered, and, unexpectedly, millions of insects (a water-beetle) got into the hatching-troughs among the young fry, and before they could successfully be transferred into other quarters, where the water was filtered, the mortality became alarming and ran into many thousands per day; so that at six weeks old, when the young fry began to throw off their sacks, their numbers were reduced 70 per cent. At ninety days old we had not over 50,000 of both brook and rainbow trout. At this period there appeared a trouble with many of the eyes of the trout, and one, and sometimes both, would protrude out, and finally the fish would either go totally blind or die; so that at the age of five months we did not have on hand over 25,000 to 30,000 trout. After this the mortality

became very light, and, save from carelessness, or rather from oversight in placing our plant in proper position, not to be affected by the draining of the large stone dam below us, we suffered comparatively little loss. So at six months old we found about 20,000 stock on hand measuring 4 to 5 inches; at eight months, 6 to 7; ten months, 8½ to 10 inches; twelve months, 10½ to 12; fourteen months, 12½ to 13½ inches. At twelve months we found them full of spawn, and now at fourteen months they are very heavy with spawn. We frequently find from 1,000 to 15,000 eggs in them, with strong indications of their depositing the spawn during the next three months—a phenomenon we would look upon probably unfortunate for us. As October would be soon as we should feel perfectly safe in working out their spawn; yet it may be that the first being acclimated, and our spring ranging even through the summer at 60 to 70 degrees, and they being in all other respects precocious and extremely far advanced and developed for their age, will possibly be a success in early spawning. The question will occur at once, How do you account for this remarkable rapid development? etc. Well, Mammoth Spring is 70 feet deep, 190 feet in diameter, and discharges a volume of water 60 to 62 degrees temperature, equal to a capacity of 40,000 cubic feet per minute. Some 600 yards below the spring is a masonry dam 14 feet high; hence the volume of water covers some 16 acres. This 16 acres abounds in almost innumerable *varieties* of aquatic weeds and mosses, and upon one of these plants there is bred millions of periwinkles (snails)—an inexhaustible supply. Now, these plants and their periwinkles afford the fish a superabundance of animal life which, together with the beef-liver we feed them, causes a marvellous growth, and a healthy growth too. Again, there is a sufficient quantity of iron in the water to ward off disease, and a scientist will at once detect the presence of iron in the beautiful tinge the

rainbow exhibits upon the California trout and the bright red spots upon the brook trout. We feed only beef-liver, but the animal life that clings to the plants counteracts any taste the beef-liver might convey to the trout. Our supply of water is inexhaustible; hence this is a large factor of success. Our ponds are separated from the main spring pond by a dirt lever. The English watercress covers our pond, and each sixty days we have to thin it out or it will be impassable for the trout to swim in. This article is lengthening out, I fear, to a size of interest to the writer only, and I will say that any reader of same that may wish any items of our farm they will be cheerfully furnished upon application. Any pisciculturist reading this will see that the writer is not of his class, but rather a poor excuse for an amateur, but the facts are here to show for themselves. We have rainbow and brook trout 13½ inches long at that number of months old.

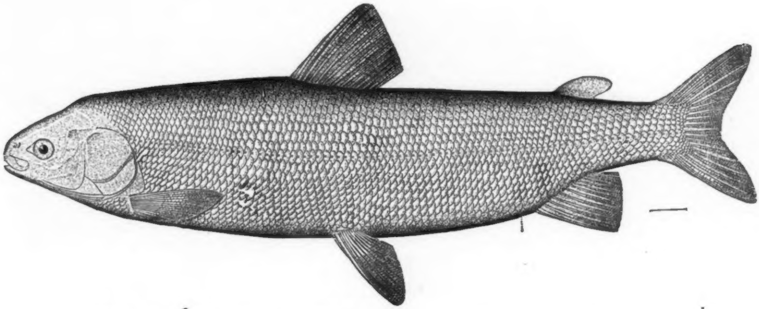

Fig. 1.—The Broad Whitefish. (*Coregonus richardsoni*).

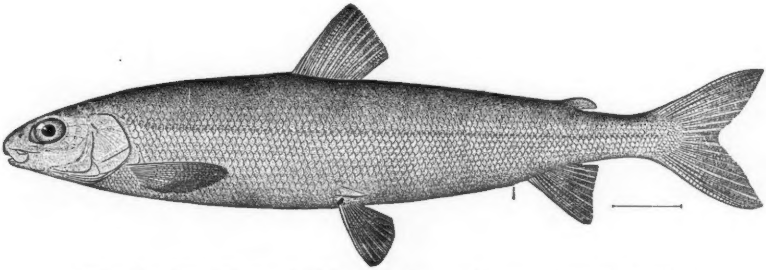

Fig. 2.—The Round Whitefish. (*Coregonus quadrilateralis*).

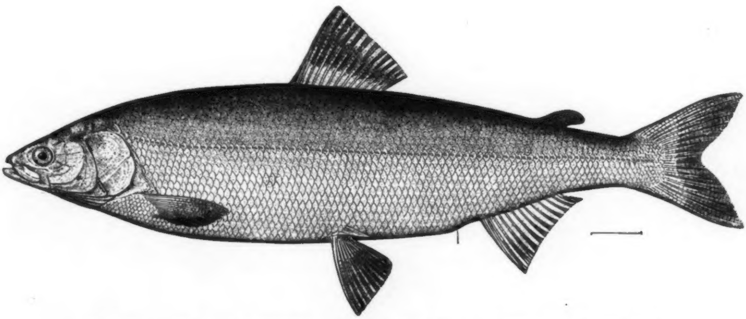

Fig. 3.—The Lauretta Whitefish. (*Coregonus laurettae*).

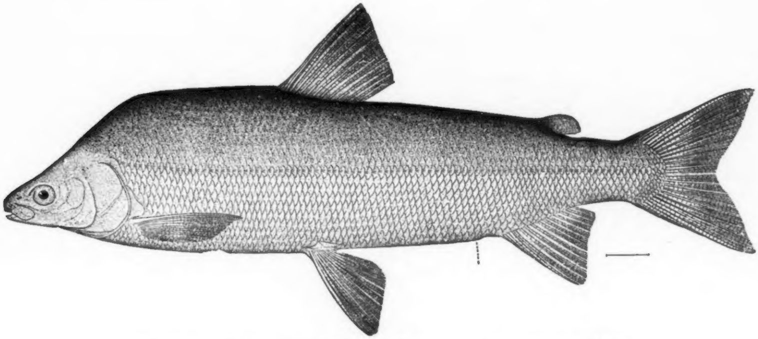

Fig. 4.—Nelson's Whitefish. (*Coregonus nelsoni*).

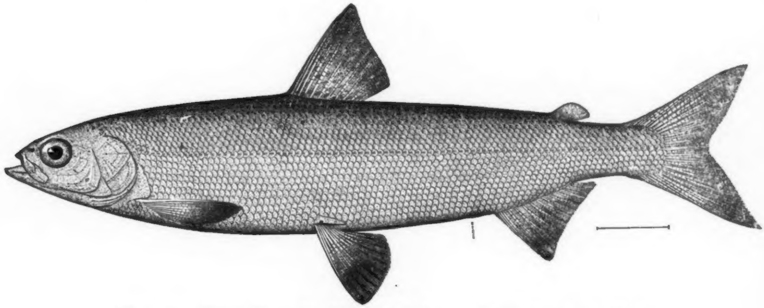

Fig. 5.—The Small Whitefish. (*Coregonus pusillus*).

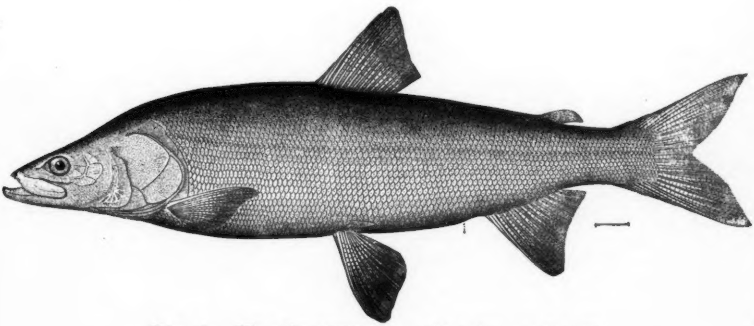

Fig. 6.—The Inconnu. (*Stenodus mackenzii*).

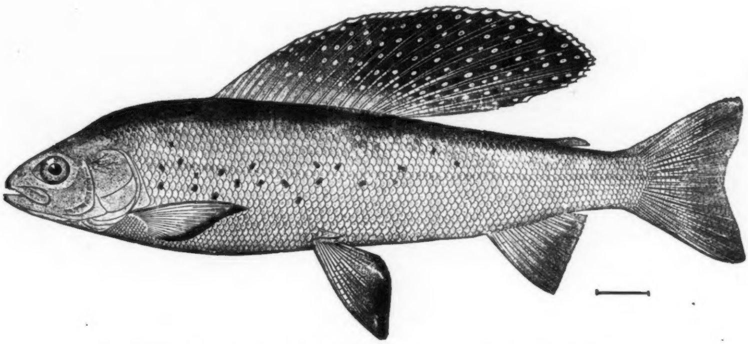

Fig. 7.—The Alaska Grayling. (*Thymallus signifer*).

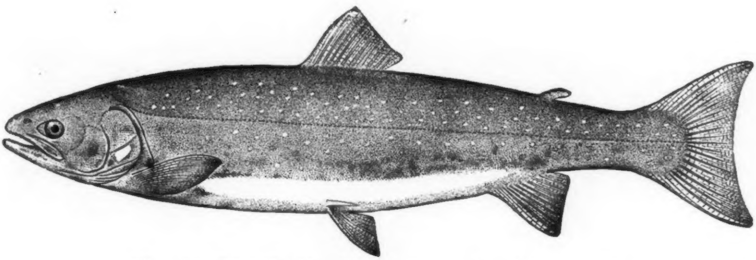

Fig. 8.—The Dolly Varden. (*Salvelinus malma*).

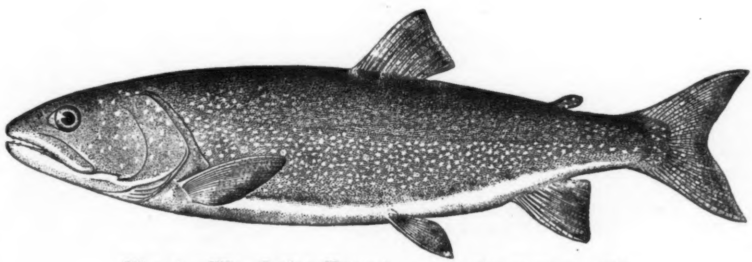

Fig. 9.—The Lake Trout. (*Salvelinus namaycush*).

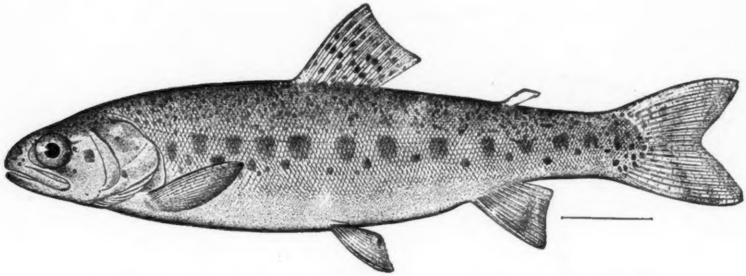

Fig. 10.—The Rainbow Trout. (*Salmo irideus*) *Young.*

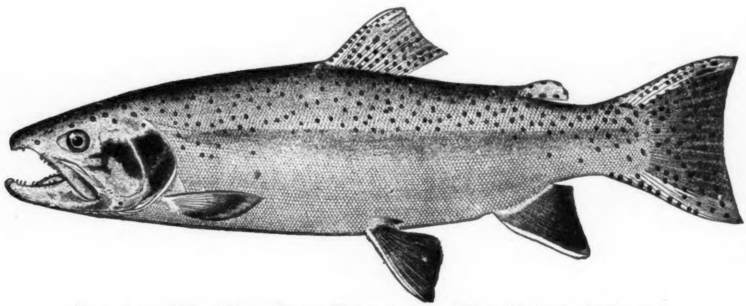

Fig. 11.—The Rainbow Trout. (*Salmo irideus*) *Adult male.*

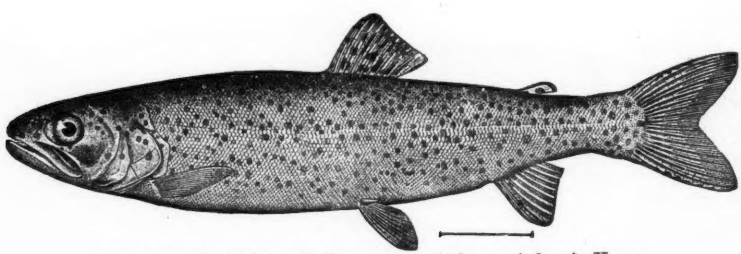

Fig. 12.—Gairdner's Trout. (*Salmo gairdneri*) *Young.*

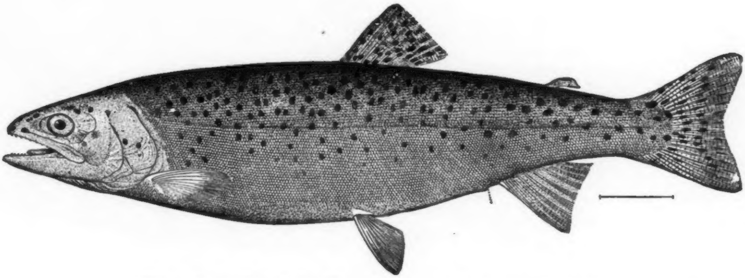

Fig. 13.--Clark's Trout. (*Salmo purpuratus*).

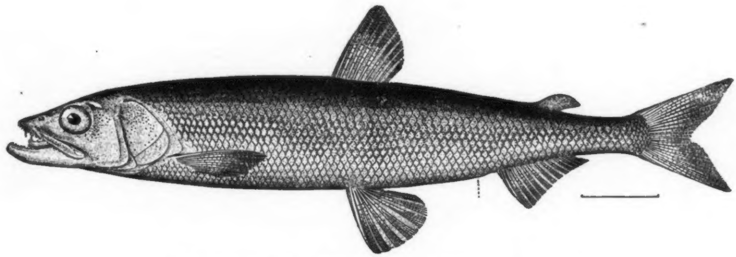

Fig. 14.—The Smelt. (*Osmerus dentex*).

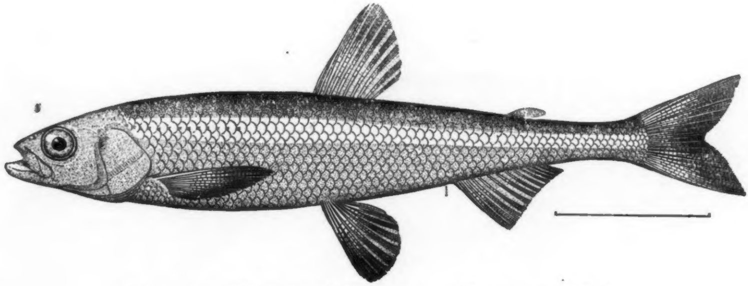

Fig. 15.—The Surf Smelt. (*Hypomesus olidus*).

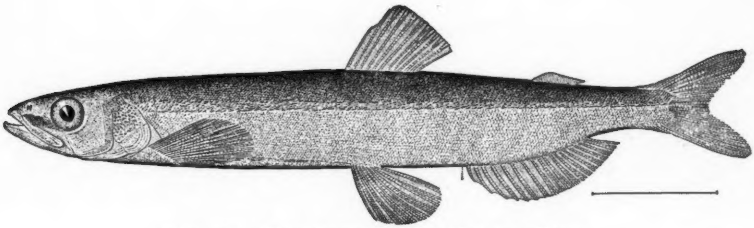

Fig. 16.—The Capelin. (*Mallotus villosus*).

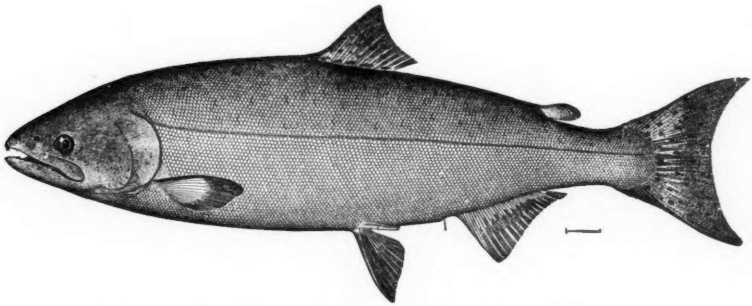

Fig. 17.—The King Salmon. (*Oncorhynchus chouicha*).

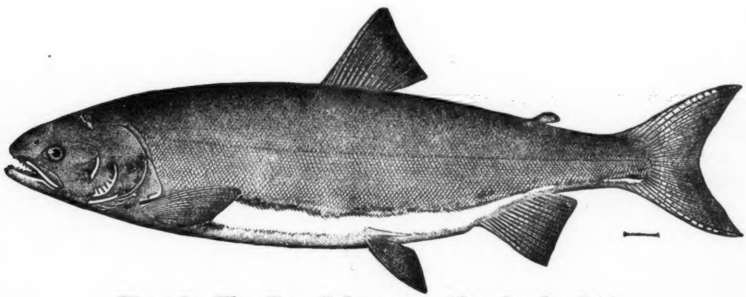

Fig. 18.—The Dog Salmon. (*Oncorhynchus keta*).

Fig. 19.—The Silver Salmon. (*Oncorhynchus kisutch*).

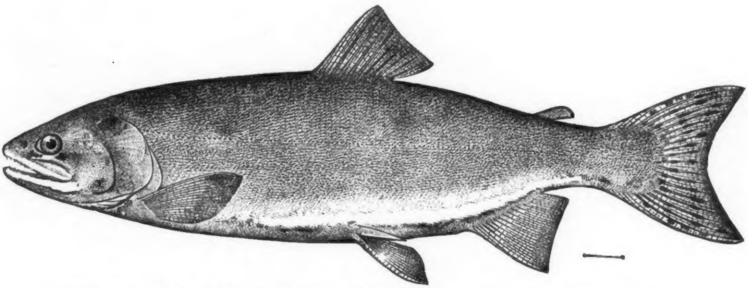

Fig. 20.—The Humpback Salmon. (*Oncorhynchus gorbuscha*).

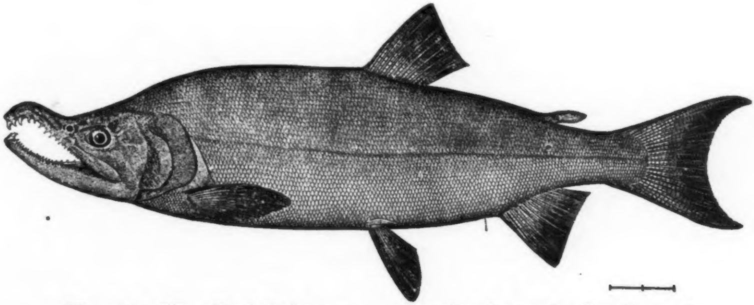

Fig. 21.—The Red Salmon. (*Oncorhynchus nerka*) *Breeding male.*

THE ALASKAN SALMON AND THEIR ALLIES.

By Tarleton H. Bean, Ichthyologist of the United States Fish Commission.

The greatest wealth of Alaska is represented by its fishes, and among these by far the most important are the members of the salmon family and other closely related forms, such as the white-fishes, grayling, smelt, and capelin. The salmon alone represent an annual value for canning purposes of about $3,000,000, derived almost entirely from three species.

The undeveloped resources which may be obtained from the salmon-like fishes have undoubtedly equal importance with the material now utilized.

In March of the present year, I delivered an address on the salmon of Alaska, in the National Museum, under the auspices of the scientific societies of Washington. This lecture was published in part in *Forest and Stream* of April 3rd and April 10th, 1890, and is made, to a considerable extent, the basis of the remarks which follow :

For eighteen centuries literature has noted the passage from sea to stream of the anadromous salmon. Nobody knows whence it came, no one can tell whither it strays. River and lake, perhaps since tertiary times, have furnished it a birthplace and a scant subsistence, while generous ocean has given it sea room and ample nourishment, converting it gradually into a thing of beauty, majesty, and mystery—the crowning reward of the angler's skill and a prime recompense of the toil of fishery.

No principal division of the earth's surface within Arctic and temperate limits, except South America, lacks representatives of the salmon family. Even in South America man has attempted to supply what nature has omitted, but we are not yet informed of the result of the experiment. Tasmania and New Zealand have demonstrated the prac-

ticability of acclimatizing the river-trout and sea-trout of England, while France and Germany are congratulating themselves upon the successful introduction into their waters of our rainbow-trout and quinnat-salmon from California.

In the distribution of the *Salmonidæ* Alaska received a generous share. Lying entirely within the area in which the family is indigenous, plentifully supplied with long water-courses, rapid snow-fed streams, and cool, deep lakes glistening in mountain valleys, over beds of clean gravel and boulders intermingled with sheltering water-plants, free from obstructions to the movements of the migratory species, its invitation to the salmon to come in and possess the waters and multiply therein was readily accepted.

Ichthyologists at present recognize about one hundred species in the family under discussion, divided among the genera of true white-fishes, nelma white-fishes, grayling, Pacific and Atlantic salmons, brook-trout, the short-lived ai of Japan, and the lenok of Siberian rivers and lakes. All of these genera, except the last two, occur in our outlying province, and they are represented by seventeen known species, or about one-sixth of the entire number.

The rivers and lakes of Alaska contain five species of white-fish, the largest one (*Coregonus richardsoni*, Plate I,* fig. 1) sometimes reaching a weight of thirty pounds. For many years this was believed to be identical with the common white-fish of our great lake fisheries, but it differs from this in many particulars. The species was known to the Russians as the "*muksun.*" In the report of the Commissioner of Agriculture for 1870, p. 386, Dall refers to it as the "broad white-fish," which, he says, "is usually very fat, and very good eating. It abounds in both winter and summer; spawns in September in the small rivers falling into the Yukon." This is the species which Milner named *Coregonus*

* The line under the tail of the figures represents one inch of the length.

kennicotti, in honor of Robert Kennicott. Captain E. P. Herendeen, of the Signal Service Expedition to Point Barrow, found this white-fish in Meade River in October, 1882. This stream is a tributary of the Arctic Ocean to the eastward of Point Barrow. The southern limit of this species is not known, but it probably extends at least as far south as the Bristol Bay region. The great size and fine quality of its flesh make it one of the most important food-fishes of the territory.

The round white-fish, shad-waiter, or chivey of New England (*Coregonus quadrilateralis*, Plate I, fig. 2), extends through the upper great lake region, the Northwest Territory, and other parts of British Columbia, into Alaska. Specimens have been obtained as far north as the Kuwuk, or Putnam River, a tributary of Hotham Inlet. This fish does not reach a large size, seldom exceeding two pounds in weight, but it is very abundant and very palatable, and, consequently, is an important food resource.

A third species, called *Coregonus laurettæ*, Plate I, fig. 3, abounds from the Bristol Bay region to Point Barrow. It is a little larger than the round white-fish, but seldom exceeds three pounds in weight. It resembles the so-called lake herring (*C. artedi*) of the great lakes, and is an excellent food species.

The fourth species is known as the hump-back white-fish, and was named in honor of Mr. E. W. Nelson (*Coregonus nelsoni*, Plate II, fig. 4). It bears considerable resemblance to one of the Siberian species, from which, however, it can be readily distinguished. As food for man it has little value, but enormous quantities are consumed by the dogs. This species is found in all parts of the territory from the peninsula of Alaska northward. Breeding males have a very large hump developed on the nape, which is compressed to a thin edge.

The fifth species of white-fish (Plate II, fig. 5) is the

smallest of all, and has a reputation of being more bony than any of the others. It is used chiefly by native travelling parties and as food for dogs. This fish seldom exceeds a foot in length, and an average weight of less than one pound, but it extends over a very large portion of Alaska, and is represented by a vast number of individuals. As far as our information goes it is found in all parts of the territory except the southeastern portion.

The largest and handsomest fish of this category is the so-called Mackenzie River salmon or *inconnu* (Plate II, fig. 6), which is known to the Russian-speaking people as the *nelma*. This species is intermediate between the white-fish and the salmon. It has a strongly projecting lower jaw, on account of which the additional name of shovel-jawed white-fish has been applied to it. This beautiful species attains to a length of five feet, and individuals weighing fifty pounds are recorded. It occurs in the rivers during the greater part of the year, is in the finest condition in the early summer, and is "full of spawn from September to January, when it disappears." The species is known to occur from the Kuskoquim to the Kuwuk. The largest individuals are recorded from the Yukon. It is found also in the Mackenzie. A closely related species is found in the Volga and other rivers of Russia, and is attributed also to the Obi, Lena, and Colima, which flow into the Arctic Ocean.

The grayling (*Thymallus signifer*, Plate III, fig. 7) is a very common fish in Alaska, especially in the northern portion of the territory, and it is one of the most attractive of all the Alaskan fishes. At one time the grayling had the reputation of being the only fish in the fresh-water of Alaska that could be caught with hook and line. It is known also as the "blanket fish," and occurs southward at least to the Nushagak region, where McKay found it "very abundant in small rivers and lakes." He speaks of it as "a good

food-fish, much sought after by the natives in the fall, along with the white-fish and the great smelt." The high and beautifully colored dorsal-fin of this species, the rich purple lustre of the sides, and the jet-black spots not far behind the head, make it one of the most conspicuous and beautiful species of the fresh-waters.

The red-spotted brook-trout of California, also known as the dolly varden (*Salvelinus malma*, Plate III, fig. 8) is one of the best-known and most abundant fishes of Alaska. In the sea-run condition, when its sides are uniform silvery and do not show the red spots, it is called the salmon trout, and, preserved in brine, forms a staple article of commerce. In Alaska the species increases in size northward. Individuals measuring thirty inches in length and weighing eight or ten pounds are frequently obtained. Natives of northern Alaska make waterproof clothing from the skin of this trout. The dolly varden abounds in all parts of the territory, even in the Aleutian Islands and in the extreme northern limits. It is known to occur also in the Mackenzie and in the tributaries of the Saskatchawan—this basin apparently representing its eastern limit. The dolly varden takes the artificial fly very freely. On one of the islands of the Shumagin group several hundred individuals were so captured in one hour by a party from the United States steamer Albatross in 1889. Salmon eggs prove very effective also in taking this trout, and it is very destructive to the eggs of the various species of Pacific salmon. The young trout are destroyed in enormous numbers by gulls, terns, and other aquatic birds.

The lake trout, Mackinaw or namaycush, tuladi, togue, lunge, etc., etc., of the great lakes, New England, Labrador, Idaho, and British America (Plate III, fig. 9), has been obtained in the Putnam, or Kuwuk, River, where it reaches a fine state of development. The southern limit of this species in Alaska is not known. This is the largest trout of North

America and the most widely distributed. Its great size and the good quality of its flesh render it a very important species wherever it is known. This is one of the most variable of the North American trout in color, and much confusion has arisen from this circumstance. Individuals from the Kuwuk are similar in appearance to Labrador specimens, differing only in being slightly darker.

The rainbow trout of California (Plate IV, figs. 10 and 11), appears to extend northward into southeastern Alaska, but is very little known in the territory, and, consequently, is not of much importance there. One specimen of this trout was taken at Sitka by Captain Beardslee about ten years ago.

Gairdner's trout (Plate IV, fig. 12), known also as the steel-head salmon, or "*soomgah*" of the Russians (*Salmo gairdneri*), reaches a very large size in Alaska, and extends northward at least to the Bristol Bay region. At Sitka this species is called "*Ah-shut*" by the Indians. We found gravid females at that place in June. This trout generally finishes its spawning before the arrival of the salmon, and is charged with the destruction of salmon eggs in large quantities. The species has not much importance, commercially, although it reaches so large a size, attaining to the proportions of the Atlantic salmon, which it resembles in shape and color; but small quantities are dried by the natives and at the various fishing stations. This is the trout which is shipped from the Columbia River early in the spring to markets on the east coast, and sold in the fresh state under the trade-name of "Kennebec salmon." It will undoubtedly become an important species before many years. At the present time it is practically a waste product of the salmon fisheries of Alaska, and the same may be said of the dolly varden.

Clark's trout, Plate V, fig. 13, recently styled the red-throat (*Salmo purpuratus*), is very abundant in Alaska, extending

northward at least to the Bristol Bay region. In the streams it can be readily taken with various baits, and greatly increases the pleasures of angling. As a food-fish its quality is excellent, and it reaches a weight of 20 pounds or more. The species is black-spotted, the spots being larger and less numerous in Alaskan individuals than in most of the varieties which range southward in the Rocky Mountain region. The crimson streak around the throat is a conspicuous characteristic color-mark in all the many forms of this well-known trout.

Before passing to a review of the Pacific salmons we must recall the fact that Alaska has a bountiful supply of small fishes which are closely related to the *Salmonidæ*.

A true smelt (Plate V, fig. 14) and two kinds of surf-smelt (Plate V, fig. 15), are among the common fishes, the first being a food-fish of considerable value. The capelin (Plate VI, fig. 16), abounds on all parts of the coast, and is one of the most important food species of the cod and salmon. The eulachon, or candle-fish, is extremely abundant in southern Alaska, and is considered one of the finest pan-fishes known. A kind of fat is expressed from it which the Indians use as a substitute for butter, and some pharmacists in the place of cod-liver oil. The species is so full of oil that when dried it will burn with a bright flame, so that when the overworked Indian has finished a bountiful supper of fish—doubtless procured and prepared for him entirely by his frivolous wife—he needs merely to touch a match to the tail of a dried eulachon and light himself to bed. In addition to their value directly as food for man, these allies of the salmon play a very important part in attracting the larger commercial fishes of the salmon family to certain localities.

The largest and finest of the Alaskan salmon is the king, or chowichee, known also as the Takou, Columbia River, chinnook, and quinnat (Plate VI, fig. 17). This valuable fish

occurs in the large rivers, as a rule, but runs into some of the small streams also, notably the Karluk and some of the rivers of Cook's Inlet. The Yukon and the Nushagak are the greatest king-salmon rivers in Alaska. The average weight of this salmon is above 20 pounds, and individuals weighing upward of 100 pounds are on record. At St. Paul, Kadiak, Mr. B. G. McIntyre weighed one which registered 87½ pounds without its viscera, and the entire fish must have exceeded 100 pounds. Captain Wm. Kohl has recently told me that he once obtained reliable information in Cook's Inlet of a salmon weighing about 140 pounds, and individuals of equal size are reported in the Yukon. These large fish are interesting in connection with the solution of the problem whether all king-salmon die after spawning, as some competent observers positively assert they do. The flesh of this species is superior in flavor to that of all the rest. In Alaska the bellies are salted, but the fish is used chiefly in the fresh state and for canning. Three of these salmon will make a case of 48 pounds. This is one of the greatest travellers in the territory, ascending the Yukon more than 1,500 miles from its mouth. The natives of Karluk watch from the headlands for its arrival in May, and set up a great shout when they have discovered this pioneer of the salmon hosts. Like the other species, it can be seen 1½ miles off shore in great schools, which break up before approaching close to the land.

The dog-salmon (*hyko* of the Russians), Plate VI, fig. 18, is not used by Americans, but it is one of the most important species to the natives. It is found chiefly in the small rivers and creeks, and is usually abundant in all parts of the territory as far north as Hotham Inlet, and probably Point Barrow. When it arrives from the sea its flesh has a beautiful red color, but it deteriorates rapidly in fresh-water. The jaws become en-

larged and distorted during the breeding season, and the flesh unpalatable. To the exaggerated size of the teeth at this time is due the name dog-salmon. The average size of the species is about 12 pounds, but individuals of 20 pounds are not uncommon. Early in July the fish-drying frames on the shores of Cook's Inlet are brilliant with the flesh of the dog-salmon. The natives cut off the head, split the fish in halves, which remain attached at the tail, remove the backbone, and gash the sides at short intervals, to facilitate the drying process.

The fur-traders lay in a large stock of this dried salmon, which is known as *ukali*. Many small streams of Alaska never contain any other salmon than dog-salmon and humpbacks, and for the very good reason that when these fish begin to run in they occupy the whole of the water and sometimes a narrow strip of the adjacent land besides.

The silver-salmon (Plate VII, fig. 19), is not so highly esteemed in northern Alaska as it is in the Puget Sound region; it is used to some extent for canning, but it is far less important for this purpose than the red-salmon. Its average weight is less than 15 pounds, and the maximum about 30 pounds. Running late in the fall, when the fishing season is nearly closed, it is not much sought after by the whites. The natives, however, dry it in large quantities.

The humpback (Plate VII, fig. 20), so called because of the enormous hump developed on the back of the male during the breeding season, is the most abundant salmon of Alaska, and, doubtless, of the world. It has given rise to more tales suspected of being fish-stories than any other fish in the territory. One collector in the Norton Sound district, speaking of its advent from the sea, remarked that "they appear at the surface of the water like the pin-drops of an April shower." A gentleman who lived eight years at Karluk informed me that about the 6th of July, and con-

tinuing for five weeks, there was in the Karluk River a glut of humpbacks which kept all other salmon out of the stream. It was impossible to pull a boat across the river. A haul was made with a 90-foot seine at 6 A.M., and the men were dressing fish from that haul until 6 P.M., caring for about 140 barrels, or about 11,200 fish, during twelve hours. After this they were occupied three hours in clearing the seine, in which the remaining salmon were about four feet deep. I do not think of any way of intensifying the statement of fact here recorded, for it is a fact repeatedly observed and abundantly verified. When the humpbacks enter a stream in force they simply fill the water from shore to shore and from bottom to top. This is the smallest of the Pacific salmons, averaging about five pounds in weight and seldom reaching ten pounds; but it makes up in numbers what it lacks in size, and it occurs throughout the territory and eastward to the Mackenzie River. As a food-fish, in the sea-run condition, it is excellent. It is salted in moderate quantities for disposal in San Francisco and other markets. Natives dry it, either with or without salting, and store up vast numbers for use in winter.

The red-salmon, or red-fish (Plate VII, fig. 21), also known as blueback and *sawqui*—the *krasnya ryba* of the Russians—next to the humpback is the most abundant salmon of the territory. Commercially, it is the most important fish, and, indeed, the most valuable product of Alaska. The Government has a prospective revenue of $1,000,000 annually from its seal islands. The people engaged in the salmon-fishery last year took about $3,000,000 worth of fish from Alaskan waters, and they were chiefly the little red-salmon. This is not a large fish, for it averages only seven or eight pounds in weight; individuals weighing fifteen pounds are occasionally seen. Like the king-salmon, it travels the whole length of rivers, pushing on to their sources, but,

unlike its big relative, it spawns chiefly in lakes. We have traced it with certainty as far north as the Yukon. It is said that the species will not enter a river which does not arise from a lake, and abounds only in snow-fed streams.

The marine life of the Alaskan salmon is unknown from the time the young, in their newly-acquired silvery dress, leave the fresh-water nursery to become salt-water sailors, until they have ended their cruise, obtained their liberty, and come ashore, when, as in the case of so many other salt-water sailors, their serious trouble begins. Salmon remain in fresh-water until the second or third spring of their existence, and, not having a bountiful supply of food, they grow very slowly, and seldom exceed eight inches in length when they start seaward. In the ocean they feed on the capelin, the herring, and a small needle-shaped fish called the lant. They are reputed also to consume large quantities of pink-fleshed crustaceans, and derive from them their attractive color. Opposed to this theory is the fact that many other sea-fishes whose food consists almost entirely of such crustaceans are never pink-fleshed.

There is no fishery at sea for any of the Pacific salmons as there is in the Baltic for the Atlantic salmon. After the great schools have broken up and the scattered fish come into the bays, some of the species can be caught on a herring-baited hook by trolling.

The king and silver salmon are captured in this way. As a rule the fish remain at sea until they are about ready to deposit their eggs, and then they approach the coast in great masses. A few young males accompany the schools every year, and may or may not return to sea without entering the rivers. The adult fish come up from the sea at a certain time of the year, the king-salmon arriving first in the month of May in Southern Alaska and about

the 6th of June in Norton Sound. The dog-salmon and the red-salmon appear in June, the humpbacks in July, and the silver-salmon in August. The length of their stay at the river mouths before ascending and the rate of ascent to the spawning-grounds depend upon the urgency of the breeding condition. In the long rivers the king-salmon travels from twenty to forty miles a day; this species and the red-salmon are reported to be the greatest travellers. The silver and dog salmon, however, are recorded by Dr. Dall as traversing the Yukon at least 1,000 miles. As a rule, they frequent the smaller streams, and the little humpback runs into mere rivulets.

From the time the salmon enters fresh-water it begins to deteriorate in flesh and undergoes remarkable changes in form and color. Arriving as a shapely fish, clad in shining silvery scales, and with its flesh pink or red, it plays around for a little while between salt-water and fresh, and then begins its long fast and its wearisome journey. No food is taken, and there are shoals, rapids, and sometimes cataracts to be surmounted; but the salmon falters not, nor can it be prevented from accomplishing its mission by anything but death or an impassable barrier. Its body soon becomes thin and lacerated, and its fins are worn to shreds by contact with sharp rocks. In the males a great hump is developed on the back behind the head, and the jaws are lengthened and distorted so that the mouth cannot be closed. The wounded fish are soon attacked by the salmon fungus, and progress from bad to worse until they become unsightly. In the mean time the body colors will have varied from dark gray in the humpback, with the lower parts milky white, to a brilliant vermilion in the red-salmon, contrasting beautifully with the rich olive-green of its head. The excessive mortality of salmon during the ascent of the streams and on the breeding grounds has led to the belief that none of the spawning

fish leave the fresh-water alive. There is a substantial basis for this view in the long rivers, and it is doubtless true that a journey of 500 miles or more is followed by the death of all the salmon concerned in it.

The nest is a very simple affair, or it may be wanting. The humpback struggles and crowds up a few rods from the sea, and deposits its eggs between crevices in the boulders covering the bottom, or sometimes they are strewn in thin layers over a large area in shallow water without covering of any kind. The king-salmon seeks the head-waters of streams, and excavates a nest in clear, shallow, gravelly rapids. The dog-salmon spawns in small rivers and creeks.

The silver-salmon does not usually ascend streams to a great distance, and I have seen it return to salt-water alive, after spawning. The nest is made among gravel and stones, from which all dirt and slime has been removed. Both sexes take part in the building operation, and the male especially guards the nest. Turner states that the silver-salmon use their snouts in collecting material for the nests, and he has seen them with the nose worn off completely.

The red-salmon spawns around the shores of deep, cool lakes, and in their tributaries, preferring waters whose highest temperature rarely exceeds 55 degrees. The nest is a shallow, circular pile of stones about as large as a man's hand, and some of them smaller. The eggs are placed in the crevices between the stones.

The enemies of the salmon are numerous. Small fish, called sculpins, or miller's thumbs, swarm in the nests, and eat large quantities of the eggs. Trout devour great numbers of eggs and young salmon. Gulls, terns, loons, and other birds gorge themselves with the tender fry. When the young approach the sea they must run a cruel gauntlet of flounders, sculpins, and trout; and in the ocean a larger and greedier horde confronts them. There the adults are

attacked by seals and sea-lions. Before they have fairly entered the rivers huge nets are hauling them to the shore almost every minute of the day, during six days in a week. When they return to their spawning-grounds, bears are waiting to snatch them from the water and devour them alive. The salmon, it appears, would have been better off had it never been born in fresh-water, where its dangers are cumulative and deadly.

The methods of taking salmon are many and various, as might be expected from the extent of the territory and the variety of its fishing population. Arrows and spears are still employed by natives, and trolling-hooks are successfully used in certain bays; but all these partake more or less of the character of angling refinements. The dip-net, seine, and gill-net are universally applied; the latter even in winter-fishing, under the ice. Baskets and traps of several kinds are very useful in river-fisheries, particularly in winter.

Dr. Dall has given a full description and figures of traps constructed by Indian tribes of the Yukon and the adjacent region; these will be found in the Report of the Department of Agriculture for 1870.

Fish-traps of modern type are freely and, it is said, injuriously, used in some parts of Alaska by white fishermen, the injury charged being that of preventing the ascent of the spawning salmon. In 1889, at Ice Bay, a trap was reported which was three-fourths of a mile long, and spanned the river from bank to bank, making it impossible for a fish to pass up-stream. It is said that many of the other traps, of which there were more than fifty in operation in the territory in 1889, are so arranged as to prevent the ascent of the salmon in the rivers. According to our information, these traps are built in places that can be fenced across by driving piles about six feet apart, and stretching wire screen, which is securely fastened to

the piles. In most cases a wing is commenced beyond high-water mark, and extends to low-water mark, where a pocket, about forty feet in diameter, is placed. Then another wing is built out into the stream as far as the depth of the water will allow. All the fish which come within these leaders are caught, and the mesh of the trap is so small that no salmon over a foot in length can get through it.

The Russians built impassable racks of timbers and rocks, which enabled them to kill every salmon that came into the stream, if they desired. These were called *zapors*, and have been legislated out of existence, we trust. It was doubtless picturesque in the early days to see an Aleut standing on the crib-work of the *zapor*, with his spear gracefully poised and ready to transfix the silvery salmon; but it was like the boy's sport with the frog, and we are glad it is ended.

The great bulk of the salmon now caught in Alaska are taken in seines, varying from 600 to 1,500 feet in length, and many of them more than 20 feet deep. The mesh is generally about 3¼ inches. The seines are set from seine-boats, similar to those used for shad on the Potomac, and are hauled by from twenty to thirty men. Experience has shown that windlasses and similar appliances for saving labor are undesirable adjuncts of the fishery, at least on Kadiak, where the seining is almost entirely limited to salt-water. Fishing goes on at Kadiak six days in the week, subject only to the presence of salmon and suitability of the weather. Night does not stop the work, except for a few hours, as it is short in this latitude. At Karluk, the principal red-salmon station in Alaska, the seining beach is less than half a mile long, and the seiners are obliged to wait their turns to set. Several seines are in the water almost constantly, one behind the other.

Upward of 150,000 salmon have been taken here in a day. A first-class cannery can use about 26,000 red-salmon daily.

After the fish are caught they are carried in dories and other boats along the beach, and through the river mouth to the cleaning-houses on the river bank; or, when it is too rough, they are taken across the spit in hand-barrows. Large lighters and scows are also used as fish-carriers, and these are towed by steam launches. In the cleaning-houses the salmon are prepared for the cannery by cutting off the heads and fins and removing the viscera. Then they are washed, and finally thrown into hand-carts, to be hauled into the cannery, where they pass through various processes, almost all of which are carried on by machinery. First, they are cut into lengths suitable for the size of the can. These pieces are carried along and fed into cans, inequalities in the filling being supplied by hand-work. The cans are then topped in the topping-machine, from which they pass to the soldering-machine; and then follow the processes of venting, cooking, steaming in great retorts, cooling, japanning, and labelling. The cans are then boxed and stored in warehouses until a cargo is accumulated, and then, by means of scows and lighters, towed by steam launches, they are carried to vessels lying in the roadstead, and soon start upon a voyage to San Francisco, Portland, or Astoria, and eventually to other sides of the globe—for these are the greatest globe-trotters of modern times.

Thirty-six canneries were operated in Alaska in 1889, located principally in the southern part of the territory, none of them north of the Nushagak River, in the Bristol Bay region. Nearly one-third were established on the Kadiak group of islands, and these secured fully one-half of the Alaskan catch. Sixty-six vessels were engaged in carrying the equipment and workmen for these canneries and the products of their industry. There were 13 steamers, 4 steam schooners, 1 ship, 13 barks, 2 brigs, 10 barkentines, and 23 schooners.

Hundreds of boats of various kinds—dories, seine-boats, Columbia River boats, besides scows, lighters, and steam launches—are employed in the business. The seining is done chiefly by white men, and the work inside the canneries by Chinese. It is estimated that 4,000 men are engaged in the salmon fishery. The capital invested in 1889 was nearly four million dollars, and the value of the pack, at an average price of five dollars per case, was about $3,000,000.

Is this tremendous drain of eight and one-half millions of salmon in a year likely to endanger the food supply of the natives? At present many of the Alaskans work for the fishing companies, and receive more than they could earn if left to themselves. Again, the dog-salmon and the humpback, which are the most abundant of the species and the most valuable for the natives, are not yet important commercially. Canneries have not extended their operations north of the Nushagak; and the territory beyond this river teems with all kinds of Pacific salmon, and especially with the two preferred by the natives.

One great source of trouble for the Alaskan people is caused by the illegal sale of intoxicants by some unprincipled persons. By this means their usefulness is destroyed, a naturally harmless disposition is incited to mischief, and there is a steady increase of victims of pulmonary diseases. Will this industry decline in value from year to year, as it has on some of the more southern rivers? Undoubtedly it will, if over-fishing and injurious methods are continued. Impassable barriers obstructing the ascent of breeding-fish will unquestionably exterminate the species in a few years. Continual seining across the mouths of rivers will certainly hasten the same unfortunate result. The necessity of protecting this valuable resource must be apparent to every intelligent person. Alaska to-day furnishes one-half of the American yield of salmon, and it

will be our own fault if the industry is destroyed. We must regulate the fishing by suitable laws, and refuse injurious privileges on Government lands. The supply must be kept up, and increased also, by artificial propagation. Fish culture cannot find a more promising field or a more propitious and urgent occasion. There are still plenty of breeding salmon; sheltered harbors in accessible localities; rivers not subject to excessive fluctuations of level, and not obstructed by natural barriers; and there are unlimited supplies of suitable water to be conveyed by gravitation alone. Materials, labor, and transportation are cheap. There are no dams, no mill-refuse, no pollutions from sewers and factories. The climate is favorable, and the population is in sympathy with fish cultural work. Surely here is an opportunity not to be neglected, and the time to improve it is now!

SMITHSONIAN INSTITUTION,
Washington, D. C., May 7th, 1890.

THE PAST AND PRESENT OF FISH CULTURE, WITH AN INQUIRY AS TO WHAT MAY BE DONE TO FURTHER PROMOTE AND DEVELOP THE SCIENCE.

By JOHN GAY AND WM. P. SEAL.

It is now almost a score of years since the passage of the bill, by Congress, which resulted in the establishment of the United States Commission of Fish and Fisheries. This may be said to be the beginning of the practical development of fish culture in the United States, for the first time, at least, carrying it on on a scale of magnitude sufficient to produce appreciable results. The record of failures and successes since that time are matters of history, and

familiar to all fish culturists. Failure is as much a part of the development of any economic theory as is success, and it is only through repeated failures that success is finally achieved. It is unfortunately the case that every failure in human effort is seized upon by those hostile or indifferent to form adverse argument, while the successes, not being attacked, attract little attention, and are often overlooked. It is probable that in the earlier years of the United States Fish Commission the high character and attainments of Prof. Spencer F. Baird alone sustained the popular interest in the work, and tided it over the shoals of legislative hostility or indifference.

Looking backward, we can see the gradual evolution of a complex but systematic scientific organization grappling with questions absolutely new and untouched, the development of methods simple and efficient from those heterogeneous and crude, and the final creation of an enthusiastic body of trained experts thoroughly imbued with a faith in the latent possibilities to be achieved in the great future of fish culture.

The fact that so great a scientific authority as Prof. Huxley should have expressed a doubt as to man's ability to diminish or in any way to control the harvests of the sea, and that, too, from the standpoint of actual investigation, together with many failures, through inadequate measures, has no doubt in the past had the effect of producing at least a very conservative feeling in the minds of many regarding the possible limits of the fish cultural attainment.

The difficulties to be encountered and the influences to be overcome were fully appreciated by the great founder of practical fish culture, Prof. Spencer F. Baird. As a preliminary to a brief review of the more notable successes of fish culture, it will be well to recall Prof. Baird's retrospect concerning the depletion of our game and fishes,

and his forecast of the progress to be expected in fish cultural development.

Concerning the influence of civilized man on the abundance of animal life, he said (Fish Cultural Report, 1878, p. 45):

"It may be safely said that wherever the white man plants his foot, and the so-called civilization of a country is begun, the inhabitants of the air, the land, and the water begin to disappear. The bird seeks a new abiding place under the changed conditions of the old; but the return of the season brings him again within the dangerous influence, until taught by several years of experience that his only safety is in a new home. The quadruped is less fortunate in this respect, environed as he is by more or less impassable restrictions, such as lofty mountains, deep rivers and lakes, and abrupt precipices, and sooner or later reaches the point of comparative extinction, or reduction to such limited numbers as not to invoke a continuance of special attack.

The fish, overwhelmingly numerous at first, begin to feel the fatal influence in even less time than the classes already mentioned, especially such species as belong to the fresh waters and have a comparatively limited range. The case of this rapid deterioration is not to be found in a rational and reasonable destruction for purposes of food, of material for clothing, or for other needs. The savage tribes, although more dependent for support upon the animals of the field and forest than the white man, will continue for centuries in their neighborhood without seriously diminishing their numbers. It is only as the result of wanton destruction for purposes of sport, or for the acquisition of some limited portion only of the animal, that a notable reduction is produced, and the ultimate tendency to extinction initiated.

Of the abundance of animal life in North America in the primitive days of its occupation by the European

immigrant we have an ample history in the accounts of the earlier travellers. Buffaloes in enormous herds reached almost to the Atlantic coast, wherever extensive plains existed. The antelopes rivalled in numbers those of Central and South Africa. The deer of various species were distributed over the continent from the Arctic regions southward, and from the Atlantic to the Pacific. The moose existed far south of its present limit. The elk was a familiar inhabitant of Pennsylvania and Virginia. Wild fowl, such as ducks, geese, swans, etc., of many species, were found during the winter in countless myriads in the Chesapeake and other southern bays and sounds.

Now what remains of this multitude? The buffalo has long since disappeared from the vicinity of the Mississippi River; the deer is nearly exterminated in many localities, though still holding its own under favorable circumstances, and the antelope is limited to restricted areas. The wild fowl, congregated at one time in bodies many miles in extent, are now scarcely to be seen, although proportionately more abundant in the winter season on the coast of California, and towards the mouth of the Rio Grande, in Texas, than anywhere else.

Perhaps a still more striking illustration is seen in the fishes. It is still within the recollection of many old people (showing how plentiful the fish must have been) that the apprentice and pauper in the vicinity of Connecticut River protested against eating salmon more than twice a week. This noble fish existed in all the waters of New England as far west as the Connecticut, and even to the Housatonic, though we have no evidence that they ever occurred in the Hudson River, or farther to the south. The shad was found in every stream of the coast from Georgia to the Gulf of St. Lawrence, and although still ascending most of these waters during the spring, has been sadly reduced in abundance.

Within even fifty years no waters of the same extent in the world could show such numbers of shad and herring as the Potomac River, below Great Falls. Martin's "Gazeteer," of Virginia, published in 1834, at Alexandria, states that the preceding year twenty-five and a half millions of shad were taken by the various Potomac fisheries, as well as 750,000,000 of fresh-water herring. This, by a moderate estimate, would amount to 600,000,000 pounds of fish secured in six weeks in this single system of waters.

This "Gazeteer" also states that during the same year nearly 1,000,000 barrels of fish were packed on the Potomac, requiring as many bushels of salt. These were consumed in the United States, or shipped to the West Indies and elsewhere. What is the condition of things at the present time? In 1866 the catch of shad on the Potomac had dwindled to 1,326,000; 1878, to 224,000—the latter not one per cent. of the yield of 1833. The catch of herring in 1833 (estimated), as stated at 750,000,000, had been reduced in 1866 to 21,000,000; in 1876, to 12,000,000; and in 1878, to 5,000,000—again less than one per cent. of the yield of the first-mentioned period.

A similar reduction has taken place in the abundance of striped bass, or rockfish, a species inferior to none in its excellence and economical value for food.

John Josslyn, Gent, in 1660, says that 3,000 bass were taken at one haul of the net in New England. Thomas Morton, in 1632, says, of the Merrimac, that he has seen stopped in the river at one time as many fish as would load a ship of a hundred tons, and that at the going out of the tide the river was sometimes so full of them that it seemed as if one might go over on their backs dry-shod.

Mr. Higginson, in 1630, says that the nets usually took more bass than they were able to land. Even so recently as 1846, 148 tons are said to have been taken on Martha's Vineyard at two hauls of the seine. *Per contra*, the catch

in the Potomac in 1866 amounted to 316,000 pounds; in 1876 to 100,000; in 1878 to 50,000. Many instances of the enormous abundance of the anadromous fishes in different parts of the country in former times could easily be adduced. Similar illustrations of the former abundance of fish inhabitants of the salt water can be brought forward to any extent. In the early days of the Republic the entire Atlantic shore of the United States abounded in fish of all kinds. Where cod, mackerel, and other species are now found in moderate quantities, they occurred in incredible masses.

The halibut, one of the best of our fishes, was so common along the New England coast as not to be considered worth of capture, and was considered a positive nuisance when taken. It is only within a few years that our people have come to learn their excellence and value; but they have disappeared almost entirely from the in-shores of New England, and have even gradually become exterminated in nearly all waters of less than 500 feet in depth.

It would be impossible, after all this lapse of years, to present more striking conceptions of the problems of fish culture than those abounding in the writings of Prof. Baird at those early periods.

Concerning the probable progress of fish culture, he says (Report, 1887, p. 18):

"A patient whose constitution has been undermined by disease of long continuance is unreasonable in expecting good results and a radical cure after a short application of approved remedies, yet he and his friends may be disappointed if the recuperation from the excesses or lesions of many years is not manifest in as many days. In reality the reverse is rather the rule, the time of recovery more frequently being much longer than the continuance of the morbific influences."

The expectations in regard to the results of fish culture

are somewhat of the same character. Although decades of years, even a century, may have witnessed the continuance of agencies for the diminution of fish in our waters, the public mind is unsatisfied, and perhaps inclined to severe criticism, if the recovery of a supply is not appreciable within the first two or three years of effort. We are, however, clearly entitled to maintain, in view of the experience of foreign countries and our own, that no reasonable anticipation in this respect will be disappointed, and that the proper measures of legislation and of artificial propagation will exhibit a marked result long before the end of the present generation. In no instance can even the beginning of a success be achieved in a shorter period than four or five years, as the young, especially of the anadromous fish, such as the shad, the alewife, and the salmon require that period for arriving at maturity. The parent fish are first obtained, the eggs extracted and fertilized, and after being hatched out, the young are finally deposited in the waters to take their chances. Whatever be the extent of time during which the progeny remain in the sea, they are more or less withdrawn from observation, and it is only when the young fish has reached full maturity and revisits its place of deposit for the purpose of spawning that its presence is appreciated.

It sometimes happens, too, that for one reason and another the first deposit of young fish proves to be a failure. They may be introduced while in a sickly condition, so that a difference of temperature causes them to succumb, or else in such small numbers that in the presence of an unusual abundance of its enemies they may all perish. What special agencies there may be in the ocean, after they reach it, we are unable to say; but from the wider dissemination their chance of escape is greater.

Again, we may misunderstand the period required for the maturity of a certain species. While four years may be considered the general average for cod and herring, five

are probably required for the Eastern salmon, and it is not improbable that the California salmon will show itself only after the lapse of six years from its birth.

The Value of Fish Culture.

The value of fish culture and the extent and value of the fishery industries are well known to the members of this body and to those directly interested, but with the great mass of our population they are not properly appreciated.

Prof. Baird has truly said (Report, 1890):

"It may be safely stated that, as a source of animal food to man, the sea is the great fountain-head, and that without this resource the supply of such food would be comparatively limited and far inferior to the demand of the various populations of the globe. In the much greater population of ocean to land this reservoir of food is practically inexhaustible; and not only do the people living near its shores find a daily supply for consumption in a fresh state, but, by proper methods of preparation and preservation, the product of the sea can be fitted for long-continued keeping and for transportation to distant markets, where fishing is difficult, or into the interior, where it is impracticable."

And again:

"It is difficult to make a comparison as to the comparative amount of animal food drawn from the ocean and the land; but it is stated ('Report of the British Sea Fisheries, 1886') that the weight of fish supplied to the London markets in 1880 was 130,000 tons, being more than 400 tons for every working-day, and equal to 1,000 fat oxen per day; and that the price paid to the fishermen for this food was only one-eighth of that paid to the first producer of beef."

It is stated in the "Report of the United States Fish

Commission for 1873, '74, '75," concerning the value of fish culture, "That a further evidence of the importance of this effort is shown by the fact that China, with its enormous population—greater to the square mile than any other part of the world—derives the greatest portion of its animal food from the interior waters of the Empire, the methods of fish cultivation there being conducted in a very efficient manner, and every cubic yard of pond and stream thoroughly utilized."

A statement of a German fish culturist, given in the "United States Fish Commission Report of 1878," is as follows:

"Christian Wagner, of Oldenberg, Germany, says: 'The area of my property would scarcely support a laborer and family, while by pisciculture it gives employment to fifteen men, three horses, and a steam-engine. The profit to myself is much greater than farmer or gardener could make off it; for the water is much richer than the field if pools are cultivated like land.'"

As to the extent and importance of the fisheries of the United States, we are told, in the report on the Fishery Industries, by Prof. G. Brown Goode and associates, that in 1880 the number of persons employed in the fisheries was 131,426, of which 101,684 were fishermen, and the remainder shoremen. The fishing fleet consisted of 6,605 vessels, aggregating 208,297.82 tons and 44,804 boats, and the total amount of capital invested was $37,995,349. It is believed that the census of 1890 will show an increase of not less than twenty-five per cent. on these figures. While the production of salt fish is decreasing, the sale of fresh fish is increasing in a greater proportion, owing to the wonderful advance made of late years in methods of refrigeration, rendering possible their preservation for an indefinite period.

This review of some of the more salient features of the fundamental ideas governing fish development and of the

great economic value of fish culture, with which you are familiar, is only for the purpose of giving a perspective, as it were, to the ideas herein to be suggested for consideration as a possible means of further promoting this great cause. It is well, also, at times to review the ground over which we have passed, so that by noting the successes our enthusiasm may be newly awakened.

We have now reached a point in the history of fish culture when we may proudly point to great results achieved in the actual and undoubted restoration of depleted waters, and from which we may fairly hope for a realization of the dreams of the enthusiasts, who have patiently plodded along in the paths laid out by the pioneers of fish culture, undismayed by the discouragements awaiting them at every turn. What has been, and is, should give a suggestion of what may be. Doubtless, in the minds of many, we have, in some directions at least, almost achieved the limits of possibility. To others, however, familiar with the statistics of output and production, increased production is only a matter of increased propagation. When we consider that in the case of the shad alone, the survival of five per cent. of the fry distributed by the United States Fish Commission will supply the entire shad-catch of the Atlantic coast, we begin to get some idea of the possibilities resulting from work carried on on a scale of adequate magnitude. When we realize that in this fish alone, since 1880, the catch has been doubled, resulting in an addition of over $1,000,000 per annum to the food production of the country, the great economic value of fish culture becomes more apparent. The great influx of shad during the present season, completely glutting the market, shows a continued rapid ratio of increase as the work of propagation is increased. The introduction and rapid spread of shad on the Pacific coast is a further proof of the beneficent effects of fish culture.

The whitefish is another notable example of the great

value of, and necessity for, extensive artificial propagation. The valuable paper by Mr. Fred Mather, read at the last meeting of the American Fisheries Society, gives evidence that in the case of that noble fish, the salmon, nothing is needed for its restoration, and perhaps a considerable extension of its range, but adequate outpout of fry.

Fish culture, therefore, we may fairly conclude, no longer needs defence, but may move forward serenely to a realization of the brightest conceptions of those who first conceived its value.

It may be well now to inquire what may yet be done by the American Fisheries Society to further promote and stimulate this great work. As to the past influence of the Society the "Report of the United States Fish Commission for 1875, '76" pays it the following tribute:

"The American Fisheries Society is an organization which has also performed a large part of the work of progress referred to. Its annual meetings begun in 1871, and continued since, invoking the presence of large numbers of experts in fish culture, as well as many members of State Fish Commissions, and giving an opportunity for the interchange of ideas and suggestions, and of forming personal acquaintances between those who are endeavoring to promote the common object. It must not be forgotten that the first authoritative suggestion of the propriety and importance of federal action in regard to the stocking of the common waters of the United States was made by this body, a committee having been appointed at the meeting of 1871 to memorialize Congress on the subject, as mentioned in the previous portion of the report. The valuable counsel and advice of the officers and members of this Association have always been at the service of the United States Fish Commission, and have been made use of in many important instances."

It is with some diffidence that the following suggestions

are presented for consideration as an inquiry as to whether this Society might not in the future occupy a still broader sphere of usefulness in promoting the great work of fish culture.

First. Should not this Society urge and demand the absolute elimination of politics from all questions concerning the organization or government of the United States Commission and the various State Commissioners? The continued attacks upon the autonomy of the United States Fish Commission are at once a menace and a warning. There are perhaps none of us who are not aware that the success of fish culture depends upon an expert knowledge gained through years of experience, and that the direction of such work can only be successful in the hands of one who is thoroughly familiar with the past and present aspect of fish culture, and who has comprehensive ideas of the possibilities in its future.

Second. Would not the influence and power for good of this Society, as a great national organization, be greatly enhanced by the establishment of State branches, having again county organizations, as in the case of other bodies having a far-reaching influence; thus to secure the sympathy and co-operation of all classes of our citizens, to disseminate a correct knowledge of the value of fish culture, and to establish an efficient system of observation and espionage of the waters of the country, without which laws are inoperative? It is well known that in the more remote districts there is utter disregard of the laws enacted for the preservation of game and fish, and that this is owing largely to ignorance or a misconception of the effects of such legislation, in the main believing it to be solely for the benefit of certain favored classes. To disseminate a proper knowledge of the work and to enlist more general sympathy would alone constitute a broad field of usefulness.

Third. Would not it be possible, through a national

organization, having branches throughout the States, to bring about a closer sympathy and co-operation among the States concerning restrictive legislation and more uniformity in methods of work? Also, to secure for the State fish commissions and the National Fish Commission more liberal appropriations as the scope of the work advances?

Fourth. Would not the preparation and dissemination of the latest and most approved literature of the subject in a popular way in the form of tracts, or through matter prepared systematically by a committee of publications for the public press, tend greatly to advance the knowledge of fish culture, or would such work be beyond the scope of usefulness desirable for the American Fisheries Society?

Fifth. Would not the collection of all the literature of the subject for purposes of reference and preservation be worthy the efforts of the Society? This of course would only be possible in the event of a permanent national organization having a proper repository.

Sixth. Would not the establishment by the American Fisheries Society of a system of rewards (medals such as are bestowed by similar bodies abroad) for able treatises upon the various branches of the science of fish culture or for the development of new and valuable ideas or methods of work tend to encourage and stimulate a more rapid development in this direction? Such medals are usually highly valued, and are undoubtedly an active stimulus to human effort.

Seventh. Would the establishment of a national school of fish culture, under the auspices of the United States Fish Commission, tend to a more general dissemination of a knowledge of fish culture and more harmonious conduct of such work throughout the country?

Eighth. There being honest differences of opinion concerning certain effects of the fishery industry upon the

fisheries themselves, would not an impartial investigation by a national organization, of the scope and influence herein proposed, tend to remove prejudice or to influence the correction of destructive methods?

As to whether or not a realization of the objects sought to be attained in fish culture may best be promoted by the independent action of heterogeneous organizations scattered throughout the country, working without unison, and often without sympathy, or by a mighty homogeneous organization, reaching from the Atlantic to the Pacific, and from the Great Lakes to the Gulf, is a matter worthy of the consideration of this body. In the minds of some, perhaps, the idea will appear Utopian; but there are some at least who feel that the time has arrived when to realize the fullest benefits possible to fish culture such a far-reaching organization is imperatively demanded.

FISH PROTECTION.

By Dr. James A. Henshall, of Ohio.

Fish protection is as important as fish culture.

After a deposit of young fish is made in suitable waters it is of the most vital importance that not only the fish, but the water itself should be properly protected, to insure the best results from such planting.

There seems to be a widespread popular fancy that the introduction of fish in any waters should be followed by a great and continual increase of such fish, without further care or consideration. Nothing could be further from the truth; but it is owing to this erroneous opinion of the people at large, and the stocking of unsuitable waters, or the introduction of unsuitable fish in other waters, that fish culture and the restocking of waters is often looked upon with doubt, if not contempt.

Different waters vary greatly in their characters and conditions, and fishes vary very much in their habits; therefore the successful stocking of waters requires much intelligent thought, consideration, and experience.

We should as soon expect to raise lobsters and oysters in the Ohio River as California salmon or brook-trout; but where the proper conditions exist and the right kind of fishes are introduced, the results will fully justify the experiment, and fish culture will achieve a triumphant success: for instance, the artificial culture and introduction of white-fish in the Great Lakes and the shad on the east coast. In fact, these results could be confidently anticipated, because the character of the waters of the ocean and of the Great Lakes are so well understood, are reasonably pure, and contain an unlimited abundance of food for both old and young fishes, and if these fishes are properly protected by the rigid enforcement of wise laws, there need never be any complaint as to the scarcity of either.

But the stocking of small lakes and streams is an entirely different matter, because of the wide difference in their character and condition. In the first place, it is necessary that the character and condition of a stream should be thoroughly and intelligently investigated before any attempt should be made in the direction of stocking it with fish of any kind; and if found reasonably pure, with an abundance of fish-food, then the kind of fish to introduce should be the next consideration. Then both of these matters being accomplished, the most important consideration is to follow—the proper care and protection of the fish *and the water*, without which it were better that the work had not been begun.

If a stream that is known to have failed in its fish supply is polluted by the refuse of mills and factories on its banks, it is useless to attempt to restore its fish-life by the introduction of a fresh supply so long as the poisonous

emanations continue. Even if the water is not poisoned to such an extent as to cause the death of the fishes, it is fatal to nearly all of the ordinary fish-food, which amounts to the same thing.

This is a matter that is not often thought of, but it is a very vital one, nevertheless, and one that lies at the very root of the cause of the decline of fishes in our inland streams. To destroy the food of fishes is to destroy the fishes themselves, or compel them to evacuate streams thus depleted of food for more favorable locations, if possible.

A farmer who shuts up his poultry in an empty house, or turns his cattle into a newly-ploughed field, and expects them to thrive and grow fat, is not more foolish than the fish culturist who plants a lot of young fishes in a polluted stream with the expectation or intention of restocking it or of restoring it to its former abundance.

Then, again, a stream may be reasonably pure, but be so obstructed by dams of saw-mills, grist-mills, etc., that fishes passing over them at certain times cannot return. It is useless to stock such streams with migratory or anadromous fishes. Only fishes of quiet and non-migratory habits should be introduced, and yet millions of brook-trout have been planted in just such streams, only to pass down over the dams, never to return.

Brook-trout streams are usually depopulated by the axe of the lumberman. In the first place, by cutting off the timber at the head of a brook, the sunlight finds entrance to its once cool, moist and mossy banks, where the feathery fern and the trailing arbutus and the partridge-berry once luxuriated, and where the larval and insect food of the baby-trout was bred in myriads; the mosses and ferns wither and die, the arbutus and the ground-pine shrivel up, the soil gives up its moisture, the insects disappear, and when the newly-hatched trout absorbs its yolk-sack, its little life

follows in the mournful train. Then the lumberman fills the little brook with logs, the spring freshets come with the melting of the snow and the warm rains, and the spawning-beds of the doomed trout are ripped up and ploughed out, and the jewelled trout disappears forever. True, if the water is pure, the stream may be restocked from year to year with yearling trout, but never again will they breed naturally, owing to the altered conditions and the lack of food for the young at the heads of the brooks or breeding-places.

As I said before, the question of fish-food, and more especially of the food for the newly-hatched fishes, is the most vital one to be considered in the re-stocking of waters. It is the food of the very young fishes—the microscopic crustaceans—that is the first to succumb to the pernicious effects of polluted waters, and it is to this cause more than to over-fishing, or seining, or dynamite, that we must impute the disappearance of the fishes from our streams.

It is important, then, that the fullest protection should be given the fishes by a proper protection of the waters in which they live. To do this every dam should have a fish-way, in order that migratory fishes can pass up the streams. This would insure the right of way to their spawning-grounds. Then, strict laws should be enacted by the legislative bodies of every State in the Union to prevent the offal and refuse of manufacturing establishments from being discharged into the streams.

No man, or company of men, have the moral or legal right to pollute or poison the waters of any flowing stream, thereby rendering the water unfit for the stock of the farmer or for domestic uses, and poisonous to the fishes or their food. If it were a fact, and could be proved, that the smoke or gases from the chimneys of factories when blown over the fields and habitations of men were poisonous to animals

and detrimental to the growth of crops, it would at once be remedied by law, or the factories suppressed as nuisances; and the law is just as able and effective and powerful in the one case as in the other.

The refuse from manufactories of all kinds, as saw-mills, distilleries, paper-mills, pulp-mills, starch-factories, oil-refineries, etc., usually found on the banks of streams, should be required by law to be run into pits and converted into fertilizers or other products, or burned, or otherwise disposed of. In most cases such a law would be a blessing in disguise to the manufacturer, for the refuse or offal could be made a source of profit, as is now being proved in several instances in various parts of the country.

If this were done, and our beautiful streams restored to their normal condition of reasonably pure waters, the work of the fish culturist and the fish commissioner would be returned a million-fold, and in many cases the fishes would multiply and increase naturally.

The net and seine fishing of the estuaries and at the mouths of coastwise streams should be regulated by good and effective laws, so that a reasonable proportion of the fishes would be enabled to pass freely and unharmed up the streams for the purpose of spawning. And the young should be protected at all times, and their catching or sale be declared illegal.

Just and rigid laws should likewise control the fisheries of the Great Lakes and large streams, and the protection of the young fish especially provided for.

The fishes of the inland streams and the *water* of the streams should be effectually protected by similar laws, which should provide close seasons during spawning-time, the prohibition of nets and seining, spearing, or the use of dynamite.

The penalties for violating these laws should be so severe as to cause a due respect for the same; but above

and beyond everything else, the pollution of the streams should be prevented.

THE SISKIWIT.

BY R. O. SWEENY, SR.

Some time ago, in a communication to Mr. G. Brown Goode, of the Smithsonian Institution, which communication was elicited by some previous correspondence with my distinguished friend, Mr. Fred Mather, upon the subject of the siskiwit of Lake Superior—in the material set forth in my letter, which was very largely the result of my own personal and careful investigation of the fish themselves, with statements from the fishermen and dealers carefully collated and compared, to secure only facts if possible—among the items so stated was that setting forth that the "siskiwit were spawning all the time," ripe fish being taken at all seasons. This anomalous condition of affairs being so at variance with my actual knowledge of the habits of fishes generally, I hesitated to put it forth without most carefully questioning the fishermen and those who have actually seen the fish lifted from the nets, and testified as to the eggs always dripping from the fish. This unusual, if not unique, habit or condition of the siskiwit has always challenged my investigation, and since my residence again upon the lake, have gathered a few more items, which may prove not uninteresting.

The siskiwit—and I find there are two of him recognized by the fishermen—are deep-water fishes, living down in the icy and mysterious profound from 600 to 1,000 feet! At this enormous depth, in this truly wondrous lake, the pressure is so enormous that the wooden floats of the nets, though thoroughly seasoned and boiled in oil repeatedly, to make them waterproof, are dragged up with difficulty,

so heavy, so water-soaked, and misshapen by the pressure as to be hardly recognizable as the symmetrical floats prepared with such care and sunk only a few hours before, many of them so crushed and broken as to be useless ever after.

'There are curious things going on in the deeps of this great abyss. One locality is pointed out, and is called by the fishermen "The Hospital," because of the great number of crippled and misshapen fish raised from the bottom; with its sharp, jagged rocks, among which a fierce, strong current seems ever surging, I conjecture to be the cause of the great number of maimed and unsymmetrical fish taken at this particular spot.

In the neighborhood of Isle Royale, in water from 120 to 150 fathoms, on a blue clay bottom, over which myriads of worms seem to swarm and upon which the siskiwit delight to feed, it is a noticeable fact that the deeper the water the fatter the fish. Indeed, the deepest-water fish are so exceedingly fat that when brought to the surface, relieved from the enormous pressure, seem almost jelly-like and ready to burst, in fact the floating oil on the surface of the lake show many of the oil vesicles are ruptured, even the bones of the head are so soft and tender that the hook or gaff tears through them, so little resistance is offered. That the relief from the deep water pressure has greatly changed the appearance of the fish there is no doubt, and the flabby, almost liquid, animal at the surface, when at its chosen habit, at from 150 to 200 fathoms, is firm of texture and as active of every function as those of the watery strata above. Upon examination, fish were found *in various stages* of development; in some the eggs are firm and hard and undeveloped, in others fully developed, soft, and ripe, ready for spawning. The males are also in the same stages of readiness; from some the milt flows freely and in great abundance; others seem spent, while others, again, seem immature and the milt undeveloped.

In November, several seasons ago, when taking our regular supply of the eggs of Namaycush, we took some of the Siskiwit eggs for intended observation of their peculiarities. Under some conditions they are slower in hatching than Namaycush, the fry are lighter in color, very decided difference in looks and behavior; they are not as active, and slower in swimming up, seem to be more delicate and susceptible to the "blue bag" development than the Namaycush, feed about the same as Namaycush, and were doing well up to middle of March, when by one of those aggravating incidents hard to guard against in experimental work, they were turned in with a large lot of Namaycush for distribution by one of the men who thought they were so few; they took up more room than they were worth.

This fish, hitherto described in foregoing pages, is of the larger and deepest-water species from the profundity about Isle Royale and that neighborhood. The largest specimens I can learn of weighed 60 lbs.—females always larger than males, whose flesh is always firmer than the spawners. The smaller species of Siskiwit rarely exceeds 30 lbs. for the female and half that weight for the male. They are taken in water at 100 to 120 fathoms. The flesh of the male is hard and firm, even when compared with Namaycush. Another very great peculiarity of his is the abundant and inordinate secretion of milt with which he is provided. In quantity and efficiency the milt of one Siskiwit is superior to the yield of six good conditioned Namaycush. It is a well-known fact that certain foods stimulate the generative functions in warm-blooded vertebrates, and no reason appears why the same should not occur among fishes. This may explain the ever-apparent readiness to spawn of certain individuals at all times among the Siskowet.

THE AMERICAN FISHERIES SOCIETY AND ITS PROCEEDINGS.

BY FRED MATHER.

This Society is now twenty years old, and has issued eighteen reports of proceedings of its meetings. By an error the second meeting, held at Albany, N. Y., February 7th and 8th, 1872, was called the first Annual Meeting (see first Report of Proceedings of the American Fish Culturists' Association, page 9); therefore the present meeting is actually the 20th instead of the 19th. The meeting of organization, held in New York, December 20th, 1870, was the first. Under this date the first printed Report (Albany, The Argus Company printers, 1872) opens as follows:

"New York City, December 20, 1870: A meeting of practical fish culturists was held in this city to-day, in compliance with a call issued November 1st by W. Clift, A. S. Collins, J. H. Slack, F. Mather, and L. Stone." It then relates that Mr. Clift was chosen Chairman and Mr. Stone Secretary; a permanent organization was formed and a Constitution adopted. The Report of this meeting appeared in newspapers only, until it was copied into the Report of the second meeting in 1872, which, as before stated, was erroneously called the first.

The earlier Reports are not to be obtained now, and I doubt if more than half a dozen complete sets are in existence. As an original member, having all the Reports, it has been thought that a review of the proceedings, in the nature of an index with notes, might be of value, and the following is offered:

LIST OF REPORTS PUBLISHED.

1. Proceedings American Fish Culturists' Association, "organized December 20th, 1870," Albany: The Argus Company, printers, 1872, [56 pages including two meetings].

2. Proceedings American Fish Culturists' Association "at its Second Annual Meeting, February 11th, 1873, Albany: The Argus Company, printers, 1873" [34 pages]. This meeting was held at the office of George Shepard Page, No. 10 Warren Street, New York City.

3. Proceedings American Fish Culturists' Association "at its Third Annual Meeting, February 10th, 1874 [48 pages], Rochester, N. Y.: Evening Express Printing and Engraving Company, 1874." Held at the office of Mr. George Shepard Page, 10 Warren Street, New York.

4. Proceedings American Fish Culturists' Association, "at its Fourth Annual Meeting, February 9th and 10th, 1875. Rochester, N. Y.: Evening Express Printing and Engraving Company, 1875." Held at Mr. Page's office, New York [43 pages].

5. Proceedings American Fish Culturists' Association, "at its Fifth Annual Meeting, February 8th, 1876, Rutland: Tuttle & Company, printers, 1876." This meeting was also held at the office of Mr. Page, New York [20 pages].

6. This Report contains two meetings; the title-page, on which the first seal of the Association appears, reads as follows: "Transactions of the American Fish Culturists' Association; Special Meeting held at the Centennial Exhibition, Philadelphia, October 6th, 1876; Sixth Annual Meeting February 14th, 1878, New York: John M. Davis, printer, 40 Fulton Street, 1877" [131 pages]. On page 46 is the heading: "Sixth Annual Meeting. The American Fish Culturists' Association held their Annual Meeting at the New York Aquarium on Wednesday, February 14th, 1877."

7. Transactions American Fish Cultural Association, "Seventh Annual Meeting, February 27th and 28th, 1878. Held at the Directors' Rooms of the Fulton Market Fishmongers' Association, New York: John M. Davis, typographer, No. 40 Fulton Street, 1878" [124 pages]. The

name of the Association was changed, as above, at this meeting.

8. Transactions American Fish Cultural Association, "Eighth Annual Meeting, held at the Directors' Rooms of the Fulton Market Fish-mongers' Association, in the City of New York, February 25th and 26th, 1879. New York: John M. Davis, typographer, 40 Fulton Street, 1879" [66 pages].

9. Transactions American Fish Cultural Association, "Ninth Annual Meeting, held at the Directors' Rooms of the Fulton Market Fish-mongers' Association, in the City of New York, March 30th and 31st, 1880. New York [no printer's name, but was done by Mr. Davis, as above], 1880" [72 pages].

10. Transactions American Fish Cultural Association "Tenth Annual Meeting, held at the Directors' Rooms of the Fulton Market Fish-mongers' Association, in the City of New York, March 30th and 31st, 1881. New York [no name, but Davis did it], 1881" [136 pages].

11. Transactions American Fish-Cultural Association [the hyphen appears in the name for the first time], "Eleventh Annual Meeting," held at above rooms on April 3d and 4th, 1882, [157 pages. Davis was the printer, but his name does not appear on title-page].

12. Transactions American Fish-Cultural Association, "Twelfth Annual Meeting, held at Cooper Institute, in the City of New York, June 6th and 7th, 1883" [83 pages. Davis printed it, but his name does not appear].

13. Transactions American Fish-Cultural Association, "Thirteenth Annual Meeting, held at the National Museum, Washington, D. C., May 13th and 14th, 1884. New York, 1884," [253 pages. Davis printed it, but his name is not on title-page]. The name was again changed at this meeting.

14. Transactions American Fisheries Society, "Four-

teenth Annual Meeting, held at the National Museum, in Washington, D. C., May 5th and 6th, 1875. New York, 1885" [106 pages; no printer's name, but Davis did it].

15. Transactions American Fisheries Society, "Fifteenth Annual Meeting, held at the Palmer House, Chicago, Ill., April 13th and 14th, 1886. New York, 1886" [100 pages; no printer's name, but Davis did it].

16. Transactions American Fisheries Society, "Sixteenth Annual Meeting, held at the National Museum, Washington, D. C., May 31st and June 1st, 1887. New York, 1887" [72 pages; no printer's name, but was done by Davis].

17. Transactions American Fisheries Society, "Seventeenth Annual Meeting, held in Elk's Hall, Detroit, Mich., May 15th and 16th, 1888. New York, 1888" [115 pages; no printer's name; the work was done by Martin B. Brown, New York].

18. Transactions American Fisheries Society, "Eighteenth Annual Meeting, held at the rooms of the Anglers' Association of Eastern Pennsylvania, Philadelphia, May 15th and 16th, 1889; Spangler & Davis, 529 Commerce Street, Philadelphia" [87 pages].

These Reports are filled with interesting papers on subjects not only connected with fish culture, but also on molluscs, crustaceans, ichthyology, chemical composition and nutritive value of food fishes, fish-ways, statistics of fisheries, and other subjects of interest, by some of the foremost scientists and fish culturists of the world. After many of the papers a discussion on the subject follows, which is often of as much importance as the paper itself, inasmuch as it gives, in terse language, the views of others on the subject, and frequently causes the writer to elucidate some point which, while perfectly clear to himself, has not been treated in detail.

It is fortunate for the owners of the earlier Reports that

they are all of uniform size to bind together, those already published making two, or better, three, handy octavo volumes, and comprising, as they do, so many subjects which cover a wide field, making almost a library of fish culture and kindred subjects.

THE CONSTITUTION AND AMENDMENTS.

1870.

ART. I. *Name and Objects.*—The name of this Society shall be "The American Fish Culturists' Association." Its objects shall be to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success; the interchange of friendly feeling and intercourse among the members of the Association; the uniting and encouraging of the individual interests of fish culturists. [Amended, 1878, after the final word "fish culturists" was added, "and the treatment of all questions regarding fish, of a scientific and economic nature," VII., 118; also changing the name from the American Fish Culturists' Association to the American Fish Cultural Association, VII., 76; again changed to present title, XIII., 238; again, 1884, name changed to "American Fisheries Society," XIII., 230-238].

ART. II. *Members.*—All fish culturists shall, upon a two-thirds vote of the Society, and a payment of three dollars, be considered members of the Association, after signing the Constitution. The Commissioners of the various States shall be honorary members of this Association, *ex-officio.*

[Amended to read that "all those who had paid $5.00, and signed the Constitution, were made members of the Association without further action," III., 4. Last paragraph making Commissioners honorary members stricken out, III., 5.

Amended, 1874, by striking out the words "all fish culturists," and inserting "any person." III., 5.

Amended, 1875, making annual dues $3.00.

Amended, 1880, members who do not pay their fees for two years to be dropped, IX., 34.

Amended, 1884, to elect corresponding members, XIII., 239.

Amended, 1881, honorary members to be approved by a two-thirds vote, X., 3].

ART. III. *Officers.*—The officers of this Association shall be a president, a secretary, and a treasurer, and shall be elected annually by a majority vote. Vacancies occurring during the year may be filled by the president.

[Amended to include a Recording Secretary, VIII., 50.

Amended, 1871, to read: The officers of the Association shall be a president, secretary, treasurer, and executive committee of three members, and shall be elected by a majority vote. Vacancies, etc.*

Amended again in 1877, increasing the Executive Committee to five [III., 5]. Again in 1878, increasing the Committee "from three to seven members," VII., 76.

In 1882, President and vice-President to hold office one year, and are then "ineligible for the same office until after an interval of one year," XI., 4.

Art. IV. *Meetings.*—The regular meetings shall be held once a year, the time and place being decided upon at the previous meeting.

[NOTE.—In 1879 it was decided "to meet again in March or April, 1880, at the call of the Executive Committee," VIII., 60. Up to 1884 there is no record of the date of any meeting being fixed at a previous one. See 13th Report, page 7—a foot-note to the Constitution].

*The transcript is made *verbatim* with punctuation as used, and capital letters as omitted. F. M.

Art. V. *Changing the Constitution.*—The Constitution of the Society may be amended, altered, or repealed by a two-thirds vote of the members present at any regular meeting.

NOTES ON THE CONSTITUTION.

A Committee on the nomination of officers was appointed at the meeting in 1871,* and the rule continued until the meeting of 1882, when nominations were made. See XI., 15. In 1884 a Committee was again appointed, XIII., 122.

A Committee to revise the Constitution was appointed in 1885, XIV., 7. It was last published in full in the Report for 1887, and some changes of phraseology made which escaped the writer's notice, but nothing important.

OFFICERS.

A history of the Society would not be complete without a record of its officers; therefore, with the exception of the members of the Executive Committees, who change yearly, and have of late years been simply ornamental, the following record is given:

Presidents: Wm. Clift, Mystic, Conn., 1870–'73, four years; R. B. Roosevelt, New York, 1874–'81, eight years; Geo. Shepard Page, New York, 1882; James Benkard, New York, 1883; Hon. Theodore Lyman, Brookline, Mass., 1884; Col. Marshall McDonald, Washington, D. C., 1885; Dr. Wm. M. Hudson, Hartford, Conn., 1886; W. L. May, Fremont, Neb., 1887; John H. Bissell, Detroit, Mich., 1888; Eugene G. Blackford, New York, 1889.

* This Committee practically appoints the officers, and has, at times, given dissatisfaction. I have steadfastly opposed this method, but have always been voted down, because the Committee disposes of the question in the least time, and the members are always in a hurry to get away. I believe it to be the very worst way to select officers, its only advantage being in saving time. F. M.

Vice-Presidents (none until 1874): Geo. S. Page, New York, 1874–'81; James Benkard, New York, 1882; Geo. S. Page, New York, 1883; Col. Marshall McDonald, Washington, D. C., 1884; Dr. W. M. Hudson, Hartford, Conn., 1885; W. L. May, Fremont, Neb., 1886; Dr. H. H. Cary, Atlanta, Ga., 1887; S. G. Worth, Washington, D. C. 1888; Herschel Whitaker, Detroit, Mich., 1889.

Secretary: Livingston Stone, Charlestown, N. H., 1870–'72; A. S. Collins, Caledonia, N. Y., 1873–'75; M. C. Edmunds, Weston, Vt., 1876; Barnet Phillips, New York, 1877–'78 (up to 1877 there had been but one Secretary).

Corresponding Secretary: Barnet Phillips, New York, 1879–'83; R. Edward Earll, Washington, D. C., 1884; W. V. Cox, Washington, D. C., 1885; W. A. Butler, Jr., Detroit, Mich., 1886–'87; Henry C. Ford, Philadelphia, Pa., 1888; C. V. Osborn, Dayton, O., 1889.

Recording Secretary: James Annin, Jr., Caledonia, N. Y., 1879–'82; Fred Mather, Cold Spring Harbor, N. Y., 1883–'88; Frederic W. Brown, Philadelphia, Pa., 1889.

Treasurer: B. F. Bowles, Springfield, Mass., 1870–'75; E. G. Blackford, New York, 1876–'88; Henry C. Ford, Philadelphia, Pa., 1889.

TREASURER'S REPORTS.

B. F. Bowles,	1873,	balance on hand	$29 08
"	1874,	"	18 83
"	1875,	"	72 58
"	1876,	no report. *	
E. G. Blackford,	1877,	no figures. †	
"	1878,	due Treasurer,	$232 25
"	1879,	"	131 70
"	1881,	"	26 73

* Mr. Bowles died previous to this meeting.

† The Report of special meeting, VII., 7, says: "Report accepted."

E. G. Blackford,	1882, due Treasurer,	$57 26	
"	1883, "	89 55	
"	1884, balance on hand,		$205 75
"	1885, due Treasurer,	102 58	
"	1886, balance on hand,		37 63
"	1887, due Treasurer,	80 17	
"	1888, balance on hand,		61 65
"	1889, due Treasurer,	5 29	

INDEX OF AUTHORS AND SUBJECTS.

In compiling this index great care has been taken, yet there may be errors in it. Cross references are given when the subject seems to demand it. For instance: Dr. Bean writes an article on "Hybrids in Salmonidæ;" it is indexed under "Bean," "Hybrids, "Hybrids, claimed to be fertile," "Salmonidæ," "Hybrids for the table," and "Trout, hybrid," covering the main points of interest.

The references are to the number of the Report, not to the year—as: "XIII., 91," for Thirteenth Report, 91st page.

Trusting that the index may be of value to those who may wish to look up any subject that has been treated of, or discussed by the Society, or who need to refer to the opinions or the writings of individuals, the following is offered.

INDEX TO AUTHORS AND SUBJECTS.

* Often Mr. Green had no heading to his papers, and when he did, he had a habit of straying over so many other subjects that it is difficult to index them.

* This was premature; no fish resulted.

* In this case the writer mistakes the Adirondack "frost-fish" for the smelt, being led astray by Mr. Wilson, whom he quotes. The spawn of the smelt is adhesive, but that of *Prosopium quadrilaterale* is not. At this late day I don't see how I made this blunder. F. MATHER.

*This is an error. I had then never seen the eggs of *Microgadus*, and accepted the bunches which the fishermen brought me, and called tomcod eggs. The next year I took eggs from the fish and learned that they were free eggs. What the eggs were that I sent to Prof. Ryder I do not know.
F. MATHER.

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